

A N
E S S A Y
O N T H E
BATH WATERS,
In Four P A R T S:

C O N T A I N I N G

A Prefatory INTRODUCTION on the Study of
MINERAL WATERS in general.

PART I. An Account of their possible Impregnations.

PART II. The most approved Means to be used for
the Discovery of their Contents.

PART III. Experiments on the Bath Waters, with
an Application of the foregoing Rules
to a Discovery of their Contents.

PART IV. On the Effects of the Bath Waters on
the human Body, and the Propriety of
their Use in Medicine, with an Applica-
tion of the Experiments to Medicine and
Pharmacy.

By WILLIAM FALCONER, M.D. of BATH.

Quæ præsentis opusculo defunt, suppleat ætas; non enim differendum est tyrocinium in senectutem. Nam quotidie crescit metus, majusque sit semper quod ausuri sumus: & dum deliberamus quando incipiendum, incipere jam serum sit. Quare fructum studiorum viridem, & adhuc dulcem, promi decet; dum & venia & spes est, & paratus favor, & audere non dedecet.

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M D C C L X X I I.



DEDICATION
TO
JOHN FOTHERGILL, M. D.

DEDICATIONS are generally offered to rank and fortune alone, though when these are united with learning and abilities, they have certainly a stronger claim to our regard. For this reason I chuse to deviate from the usual course, and address the following treatise to one of the first Names in the Science and Practice of Medicine; as, whatever may be the fate of the Work itself, the public must approve my choice of a Patron. Not but I must confess I was partly swayed by a private motive, wherein my silence might justly be deemed ingratitude. Your kind concern for my welfare, and the interest you took in recommending me

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to this place, would call for my warmest acknowledgments, were you less distinguished in the profession. Permit me then to offer to your notice this enlarged, and I hope somewhat improved Edition, and to join to so respectable a name as Dr. FOTHERGILL's, that of



his faithful,

Bath,
Aug. 1,
1772.

and obliged friend,

WILLIAM FALCONER.

INTRODUCTION.

On the STUDY of MINERAL WATERS
in general.

IN the present improved state of Medical INTROD.
Knowledge, it seems remarkable, that
so little progress should have been
made in so important a branch of it, as the
Investigation of the Nature and Qualities
of Mineral Waters. Books, indeed, have
not been wanting, as I have lately been
well assured by an eminent Physician, that
upwards of a thousand Treatises have been
written on this subject only. The ac-
counts, however, transmitted to us by the
generality of these Writers, are very little
to be depended on, as they are mostly filled
with instances of the grossest ignorance, or
misrepresentation. Bold as this assertion
may appear, I am inclined to think, that,
on examination, it will appear well founded,

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and believe that those who have been most conversant in works of this kind, are abundantly satisfied of its truth. The Author would not be understood, to mean a reflection on all the Books, without exception, that have been written on the subject; he is willing and ready to acknowledge several useful and important discoveries, which are to be found in works of this kind. It must, nevertheless, be acknowledged, that if we consider the great advances made in the other branches of the Science of Medicine, and especially in that one most conducive to discoveries of this kind, *viz.* the Science of Chemistry, the Knowledge of Mineral Waters has not been proportionably improved.

A certain ingenious Writer, a native of a neighbouring kingdom, who has included in his Work a Dissertation on the celebrated Waters, which are proposed as the subject of the ensuing pages, has carried his reflections on this subject to a great length, and made many severe observations on the Faculty resident there, for their ignorance of the principal remedy in their *Materia Medica*. How far this may be true,



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true, does not become the Author of this Treatise to determine ; certain it is, that, granting it were so, which he has by no means proved, a decency of language impeaches no truth ; and had the Author observed this rule, his work would, probably, have found that reception in the world, which it justly merits by the ingenious discoveries it contains.

It is hoped the following Work will be as little obvious to objections of this kind, as the nature of the thing will admit of. Opinions, indeed, and some, perhaps, of a pretty general nature, will be found disputed ; but hope it will be done in such a manner, as not to give offence to those who have written in support of them. When opinions alone are controverted, it may be alledged, that no apology is necessary, as candour should be the inseparable attendant on learning ; and no man of Science should be ashamed to receive information from whatever chanel it may be derived. Specious, however, as this argument may seem, the practice of the world is widely different : Disputes of this nature have been generally managed with great acrimony,

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mony, and have not infrequently degenerated from mere literary controversies into personal satire and invective. This observation, though particularly true in this instance, is not confined to Medicine, it having been an old general remark, that men are at least as tenacious of their opinions as their property. I am too well satisfied of my own imperfections, to desire to enter into disputes of this nature, and am ready to own, that, however probable the following theory may seem, it is by no means, even in my own opinion, free from objections. A consciousness of this, will ever incline me to receive any information, or acknowledge any error I have made. One merit, however, I hope I may pretend to, which is, that in the following Experiments I have not falsified any fact in favour of the opinions I have adopted, nor suppressed any circumstance that may seem to contradict them. When any such have occurred, I have related them faithfully, and, as far as reason, or a just probability would support, endeavoured to reconcile them with my theory. I have not, likewise, taken any experiment on the credit of others, but have repeatedly made all those

those here related. How far I have succeeded the world must judge; but as this Work is composed, in a great measure, on a new plan, some indulgence may justly be expected.

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I shall now proceed to speak of the causes which have prevented, or at least retarded, the improvements we might have expected to have seen in this branch of Science. The principal of which are the following :

1. The want of chemical knowledge. That a certain degree of chemical knowledge is necessary to those who propose to investigate the impregnations and qualities of Mineral Waters, will scarce be denied : As a proof, however, of it, if we look into the books written on this subject, while that branch of knowledge was little cultivated, and, of course, few improvements made ; or into those of later date, whose Authors were defective in that Science, we shall be abundantly convinced of the truth of this assertion.

We there read of Waters impregnated with substances, which we know are (in

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the state they are presented to us by Nature, and of course the state in which they are generally exposed to the action of the Waters,) indissoluble in a watery fluid; or else of substances, which, although soluble in Water, we know to be mere creatures of Art, and of course such as we cannot expect to meet with amongst the operations of Nature. Experience likewise justifies this theory, and has proved most of those boasted impregnations to have been merely ideal, and reduced the number of the real and possible impregnations, into a much smaller compass than the Advocates for Mineral Waters would be willing to allow.

We must not, however, too rashly attempt to set bounds to the operations of Nature, as several surprizing and uncommon phænomena have been produced, by means that we are ignorant of. Subterraneous fires, earthquakes, &c. numerous marks of which we see in many fossil appearances, often interrupt the course of Nature, and sometimes imitate, and at others form the same productions with those

those which had issued from the hands of INTROD.
the most elaborate Chemist.

Nor must we always deny the impregnation of Waters with substances, from a pre-conceived opinion of their indissolubility in a watery menstruum; as many bodies are capable of so minute a diffusion through the body of a fluid, as to produce the same effects on the body, as they would have done in a state of solution; and by that means bring them under our definition, of Medicated, or Mineral Waters.

Neither, on the other hand, must we, from a too great confidence in experiment, attribute too much to the dissolvent power of either simple Water, or Water when combined with such substances as it might meet with in the bowels of the earth, and which might increase its solvent effects. The circumstances of these are oftentimes widely different, and many productions are exhibited, which vary greatly from those which our Theory would, at first sight, lead us to imagine; and others, which, from the great frequency of their component parts in the bowels of the earth, we might expect often to meet with in these

INTROD. researches, are seldom, if ever seen. Let it not be inferred from hence, that I would depreciate the advantages of a knowledge of Chemistry, to those who are desirous of being acquainted with the History and Use of Mineral Waters. I mean rather, to inculcate the necessity of a more accurate knowledge of the principles of that Science, which will enable the curious enquirer to explain many appearances in nature, which seem either to differ from, or contradict those which have been produced by experiment, in circumstances apparently similar, and which would perplex and confound one who had only a superficial knowledge of the subject. Many phænomena of this kind, it must be owned, have hitherto eluded the attempts of the most accurate and ingenious Chemists, to reconcile with their general principles; but as many of these have been satisfactorily explained, on a rational and coherent Theory, and many appearances, seemingly contradictory, have been found to proceed from the same general cause, it may reasonably be expected, that the remainder may not prove utterly irreconcilable with the general system.

This,

This, I hope, will prove a sufficient INTROD.
answer to those who alledge, that all attempts to discover the properties or effects of Mineral Waters on the human body, by chemical experiment, or analysis, are vain and insignificant, as there are many effects produced by them, which are not to be accounted for from any discoverable impregnation. It cannot, indeed, be denied, that there are several such still; yet it must be owned, likewise, that there were many more formerly, whose effects seemed equally inexplicable,

Later experience has, however, demonstrated, that they are not all at least equally inscrutable; and as many of their effects have, by the assistance of Chemistry, been explained on just and rational principles, what reason have we to despair that the remainder will, in time, be rendered equally clear? To assert the contrary, would, if applied equally to every branch of learning, preclude all search whatever; and had it been formerly observed, would have prevented our acquisition of many useful and important discoveries which we now enjoy.

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An accurate knowledge of Chemistry is likewise requisite in the examination of Waters, to distinguish their original contents from those which are only the product of the Experiments. From inattention to this circumstance, many mistakes have been committed, and many supposed discoveries have been made of impregnations, which never had any existence in the Water before these were made.

2dly. Abuse and confusion of terms. This cause is nearly connected with the former, and proceeds, in a great measure, from the same origin; it having been an old observation, that no science ever arrives at any considerable degree of perfection, until its terms are accurately defined. If this rule holds general, we may pronounce this branch of knowledge to be at an exceeding low ebb, as there are scarcely two Writers on the subject of Mineral Waters, who have applied the same signification to similar expressions. It is, indeed, greatly to be doubted, if the Authors themselves had any positive idea affixed to many of their terms, as they seem to be more frequently drawn from some idea of
a pos-

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a possible, or, as their fancy might suggest, probable production, than from Experiment tending to prove, that such facts had really happened. This imperfection is justly charged on most of the ancient Writers, and, indeed, was more pardonable in them, than in many of their successors the Moderns, who, notwithstanding they have wrote since more accurate and explicit ideas were affixed to chemical terms, have still pursued the same unintelligible path with their predecessors. Several Writers on this subject have been grievously faulty in this respect, as many of their terms are inexplicable, others contradictory, and no small share of the remainder scarcely differing more from each other, than they do from those things, which, from a view of their name, we should imagine they were intended to express.

Many of these Writers, like the Alchemists of old, have made a notable use of these confused and unintelligible terms, in order to cover their own ignorance, justly supposing, that no one could object to terms, however unintelligible, which the custom of their predecessors had established;
the

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the very obscurity of which would lead many to believe implicitly in the sagacity and learning of the Author, while the means of its detection must be in the hands of few, and those, perhaps, too deeply interested to make the discovery.

Had this obstacle been properly attended to in former times, we should, in all probability, have seen many of the unmeaning and unintelligible terms, which now disgrace this branch of learning, exploded, and new and explicit ones substituted in their place,

3dly. Want of method has been likewise a principal source of this obscurity, as it necessarily produces circumlocution, and not infrequently confusion.

From hence it comes, that many of these Authors are so dark and unintelligible in their ideas, and, conscious of this defect, they were, probably, unwilling to part with terms so well adapted to their purpose, being desirous, like the Painter of old, to cover with a veil what they were unable to express,

4thly.

4thly. Desire of gain has likewise been the cause of much ignorance, as well as falshood and misrepresentation on this subject. The practitioners have been fearful of making, and still more of disclosing, the event of Experiments made on the Mineral Waters which they attended, though from them they might be chiefly expected. They dreaded lest the impregnations should be discovered to be such as might be easily imitable, in equal perfection, by the hand of Art, which would deprive them of many of their lucrative sources, by preventing the resort of people to a distant place, for what would be so easily procurable at home.

Another reason, and perhaps a more justifiable one, is, that since a Patient's good opinion of the efficacy of his medicines is, in many cases necessary, and at all times favourable to his cure, by keeping up his spirits, and securing his obedience to the Physician's directions; should many of these boasted arcana, however efficacious in practice, be at once develloped, and discovered to be no more than the most common and simple substances, it might

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might diminish his confidence in the remedy, and by that means deprive him of many of the advantages otherwise to be expected from it. They were, therefore, unwilling to encourage scrutinies of this kind, being contented with a few practical observations on the effects of the Waters, and desirous that the chemical discovery of their contents should, like the Roman Palladium, remain locked up in the most secret part of the Temple, scarce to be looked on even by the Priests themselves.

The celebrated Writer before-mentioned has carried his arguments on this head much farther, and has brought several grievous accusations against the Faculty of Physic, as having, for lucrative motives, so misrepresented or falsified the qualities of the Waters where they resided, as to adapt them to every disorder, or state of it, incident to the human body. Were this charge true in its full extent, grievous indeed would be the imputation, as it would be reducing the principles of their profession to the standard of the lowest Empyricism; and, what is of still greater consequence, how melancholy must be the situation

ation of the generality of those who apply to such Practitioners for relief! To such, indeed, the advice of a late great and worthy Physician might be well applied—*To peruse the sixth Commandment.* We may be, however, fully satisfied, that this Author has carried his reflections to a very unjustifiable length. Some few might, perhaps, be found, to whom such an imputation might be applicable, as it can never be expected that the Professors of Medicine should, more than other men, be uniformly, and without exception, just and honest. But we may rest assured, that the number of these is very small, in comparison with those who would even shudder at the thought. Some prejudice, perhaps, is inseparable from our nature; it is not, therefore, to be expected, that our profession alone should be divested of it.

Many Practitioners, seeing the good effects of the Waters at which they resided, might be tempted to extend their use to more cases than their unprejudiced reasoning might fully justify. But is not this the case with the Profession in general? What Practitioner can safely assert, he has not
some

INTROD. some partiality for a particular medicine above the rest? I believe few can disavow it; and if they should be so blind to their own prejudices, those who would examine their practice would soon make the discovery for them.

5thly. The indolence of Practitioners, likewise, has been a cause that has powerfully contributed to retard the advancement of this branch of Medicine. That our principal information, in cases of this kind, must be drawn from observation of their effects on the human body, is not to be doubted. But, on the other hand, we can neither make these properly, nor attribute the effects to their true causes, unless the contents of the Waters that produce them were ascertained, which can only be done by Chemical Analysis. The observation of their effects, though by no means, if accurately performed, the less difficult task, has been more attended to, as it was necessarily coincident with the Practice of Physic; but the latter, though proper likewise to be cultivated by every one who would practise on a rational footing, not being so obviously connected with it, has been
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been more neglected. It must, indeed, be acknowledged, that the latter has some disagreeable circumstances attending it. The Experiments necessary on such occasions, though at first view, to those who have never been concerned with them, they may appear agreeable and entertaining, are, many of them, disagreeable and troublesome, either from the nature of the operation, or the quality of the substances used in them. Moreover, not a few of these are remarkably tedious, from the length of time taken up in performing them, and the care and attention of mind requisite to observe, and mark down all the different changes that occur during that period. What adds greatly to this is, the necessity of several of the most tedious of these processes being frequently repeated, in order to draw any certain conclusions from them, as the slightest variation may cause a difference in the product, which will require a renewal of the Experiment.

In the foregoing part of this Introduction, I have mentioned an acquaintance with Chemistry as a requisite qualification

INTROD. for those who make Mineral Waters their study. By this, however, more must be understood than is commonly meant by the term. A mere theoretical knowledge of the subject, though such as might be fully sufficient to answer the generality of the purposes wherein that Science is required in Medicine, would, in this case, be highly inadequate to the undertaking. A great degree of knowledge of the practical part of Chemistry is required, and a perfect acquaintance with all the changes that may happen in all the circumstances that may occur on such occasions.

A knowledge of this kind is not to be gained from historical descriptions, and can only be learned by habitude of performing the Experiments.

To the fatigue and trouble, therefore, of the one, and the time requisite for the attainment of the other, as it is, in fact, beginning a new study, which few are willing to submit to, must be attributed, in some degree, the slow progress of this branch of Science.

6thly.

6thly. Prejudice of opinion in favour of some particular theory, has likewise often misled many of the Writers on this subject, who had formed their opinions before they made their experiments. It is probable, therefore, that many of those which seemed contrary to their opinion were suppressed, or misrepresented; while others that seemed to favour it were carefully remarked.

Such are the most obvious causes that have retarded the improvement of the knowledge of Mineral Waters: But there is likewise another complaint very frequently made of Books of this kind, *viz.* that they seem to be written to the learned only; their meaning being so enveloped by terms of Art, as to render them unintelligible to the rest of the world. This evil, indeed, is scarcely to be remedied, as every Science finds it necessary to adopt peculiar technical terms to express the complex ideas, to avoid a tedious circumlocution, hardly more intelligible than the terms themselves.

The ancient Writers, it must be owned, were extravagantly addicted to abstruse terms,

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terms, which they used to express even the most simple ideas. Later improvements have greatly diminished this formidable squadron, and opened the avenues to this branch of learning, by reducing them to a few terms, and those simple, expressive, and easily understood.

The use of an accurate chemical examination of the Waters, will, it is hoped, want no proof, with men of learning and candour. Some cavils have, however, been frequently raised against any attempts of this kind, as being impossible to be brought to the desired degree of perfection; and, therefore, more apt to mislead, by substituting an uncertain or false theory, in room of an approved method, which time and experience had confirmed. The first of these objections has been, as I hope, already removed; and it might be asked farther, whether a search into the causes of effects is unworthy the Physician, or Philosopher?

To the second I would answer, that no attempt is made to overthrow the good effects of the Waters in those cases which experience has justified, or extol their use
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in others, which it has condemned. The Author is far from wishing to see a System of Medicine, or, indeed, the application of any particular article of it, founded on theory only independent of practice. But is not a search into the causes of effects consistent with a due regard to practical knowledge? Do they not mutually illustrate each other? But I hope it is needless to pursue this argument farther. I will venture, however, to point out a few of the advantages which might accrue to the public, from a work of this kind, if accurately performed.

Were the contents of the Waters ascertained, it would be likewise of service to those Practitioners who reside in distant places, who have no opportunity of making experiments on, or of seeing the effects of the Waters. They would then be enabled to judge of the proper application of these Waters in certain disorders: For being acquainted with the substances with which they are impregnated, and the effects of those substances on the human body, they may, by their knowledge of the one, form a better judgment of the other. It

INTROD. is needless to expatiate on the use of this. Moreover, as an ingenious Writer has well observed, a farther advantage arising from the analysis of Mineral Waters is, that it furnishes us with the means of making artificial combinations to resemble them. It enables us also to compare the qualities, and to ascertain the variety of the Mineral Waters which Nature affords us, and to arrange them under proper classes. It assists us also, in some measure, to make new discoveries; for should a Water present itself to our view, of such sensible qualities, as to be evidently efficacious, our best method of judging, in many cases at least, of its use in Medicine, would be to ascertain its resemblance to some other Water, with whose contents and qualities we were already acquainted. Some of them, indeed, whose impregnations are of a simple nature, and consist of substances whose effects are sufficiently ascertained, and which are found in the Water in the same state in which we use them, are easily investigated, with regard to their qualities, from the known effects of that substance when employed in Medicine. But this is far from being always the case. The greatest part
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of the impregnations of Mineral Waters are of a compound nature, and form such combinations as we have no opportunity of seeing, and, of consequence, judging of their effects in any other circumstances than as contained in Mineral Waters. With respect to these, our means of discovering, and our capacity of judging of their impregnations, though much improved of late, are still very confined. Even when we are satisfied of the existence of a substance there, we are not always able to account satisfactorily for its presence, or by what means of union with the Water it comes to make part of the impregnation. We cannot always distinguish likewise what proportion of each ingredient is contained in the compound, or what proportion each of these may bear to any given quantity of the Water. Granting, however, that all these were accurately laid down, we may reasonably believe, from the nature of several of the substances that form these impregnations, the great difficulty of collecting these together, and the still greater of combining them properly by any artificial means hitherto discovered; that our best method of forming

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a judgment of the effects of any Mineral Water that should occur to our notice in the forementioned circumstances, would be (as was before observed) by ascertaining its similitude to some other, whose nature and contents were already investigated; as we should be likely to meet with more exact parallels to it in nature, than what could be procured by any artificial preparation whatever. These may be esteemed the advantages that would accrue to Medicine in general, from the cultivation of this branch of Science; but a perfect knowledge of the Chemical Contents of the Waters, would be likewise of peculiar service to the practising Physician at the place.

The effects produced by Mineral Waters are observed to vary greatly, according to the circumstances in which they are administered, independent of those which relate to the disorder. The active principle, in many of these, is of a very fugitive nature, and, except peculiarly attended to in the mode of exhibiting the Waters, apt to disappoint our expectations from them, either by its escape, or change of nature. A knowledge of the nature of this

this substance will afford us great instruction with regard to the method of administering the Waters in such a manner as to preserve their full effect, if desired, or, what is likewise of great consequence, to moderate this, without destroying it entirely, in such a manner as may best suit the state of the disorder and circumstances of the Patient. A knowledge of the contents of the Waters would be likewise of great service on another account: Most of the Mineral Waters are very apt to have their component parts separated, (which destroys their original effect,) on admixture of almost every foreign body. As it is often judged necessary to take some medicines along with, and frequently in the Waters, a knowledge of this kind would instruct us in the choice of these, either to select such as would least alter their original nature, or else, from a knowledge of the compound formed by the Medicine and the Waters, to enable us to form some judgment of the effects likely to be produced by such a combination.

I shall now proceed to give the plan of the ensuing Work; and, first, shall premise

INTROD. mise an account of Mineral Waters in general, and of those substances with which they are capable of being impregnated.

Secondly, I shall give an account of the most approved means to be used for discovering these impregnations.

Thirdly, I shall relate my Experiments made on the Bath Waters, and endeavour to apply the foregoing rules to the discovery of their contents.

Lastly, I shall make an application of the whole to the practice of Pharmacy and Medicine.

PART

PART I.

On the possible IMPREGNATIONS *of*
MINERAL WATERS.

CHAP. I.

GENERAL DIVISION *of* WATERS.

WATER has been divided by the Chemical Writers into two kinds, but this is not quite correct, as we know but one kind of Water. Whether this Water be an element, or a compound, is not at present to our purpose to enquire; it seems, however, to have as good a title to the epithet *elementary* as most bodies.

Water, as it is capable of being united with many substances, may, from a perfectly pure state, to that of the greatest impurity, undergo various degrees of impregnation. Hence it is divided into
simple

simple or common, and compound or mineral.

This division must be rather imperfect; first, because we know no Water perfectly free from some degree of impregnation; and, secondly, as this division is only from different degrees of the same quality, it must consequently be inaccurate.

Definition
of what is
understood
by *common*
Water.

But by *common* Water they would understand such whose impregnations are not obvious to the taste or smell, and which has no sensible action on the human body.

What by
mineral
Water,

By *mineral*, where it has the contrary properties.

Even in common Water, according to this division, there are various impregnations, which may be chemically discovered from the Waters of the atmosphere, from whence all the rest proceed, to that of springs, rivers, and lakes.

CHAP.

C H A P. II.

On MINERAL WATERS strictly so called.

WERE we to attend to the various characters and analyses that have been given in Books of the different Mineral Waters, we should, at first sight, be led to imagine, that there was a great diversity of them, but, on examination, the contrary appears evident.

It has been before observed, that these facts have been in general grossly misrepresented, and as such can never be the foundation of rational conclusions. I shall not, therefore, think it necessary to pay much regard to those Authors who wrote whilst Chemistry was in a very imperfect state, but rather, in such a complicated case, prefer reasoning *a priori*, according to the advice of a celebrated Professor at *Edinburgh*, and then see if the conclusions drawn from thence are compatible with such facts as can be depended on.

In order to do this more clearly, I shall, before I enter into particulars, lay down
some

some general propositions which will serve to explain my reasoning on these subjects.

I. The impregnation of Mineral Waters must consist of native fossile substances.

II. Of these such only can be expected to be found as Water is capable of being united with, by any means that we can suppose to exist in Nature.

That the former of these propositions, in its general sense, must hold true, appears pretty evident. It admits nevertheless, if taken strictly, of some exceptions, as we have instances of vegetable and animal matter, and of some saline substances, which were generally thought to be of merely artificial production, being discovered in Mineral Waters. The cause, however, of most of the impregnations of this kind hitherto discovered, has been found to be owing to some circumstances respecting the situation of the spring, as its proximity to places which contain substances of this kind, and where they might be liable to be washed down into it; or where they have been artificially in-

introduced into the course of its current ; in which cases it might receive from them an accidental impregnation. But as these rarely occur, and never with respect to the two first mentioned substances, except in circumstances which, perhaps, cannot fairly be ascribed to Nature, I can scarce, with propriety, admit them into the Catalogue of Native Impregnations of Mineral Waters.

With regard to Saline Substances, instances have, indeed, been produced of some of these, which have hitherto been imagined to be merely artificial productions, being discovered in this manner.

Some of them may, however, be easily accounted for, in all circumstances where any impregnations of the foregoing kinds are likely to be met with, as several of them may be produced in consequence of the changes to which those bodies are liable. These, however, as was said before, as only happening like the former, in accidental circumstances, I cannot be understood to comprehend. We have, nevertheless, some accounts which favour the opinion of the existence of some impregnations of this nature,

nature, in circumstances where no cause of a similar kind could, with any tolerable degree of probability, be assigned.

There is, notwithstanding, great reason to believe, that these appearances, when they do occur, are owing to some accidental interruptions of the course of Nature, produced by some of the causes mentioned in the Introduction. But as these very interruptions make a part of the History of Nature, and happen in general, in consequence of some changes occurring in the course of it, we cannot properly reject the substances formed in consequence of them from the list of Natural Productions. Instances of this kind are, however, extremely rare, and when they do occur, are generally in so slight a degree, as to bring the Waters that contain them, under my first division of *common Water*.

In order to explain my second proposition, I shall endeavour to shew by what means Bodies in general may be united with Water, and which of these means of union are likely to occur in the course of nature.

Bodies

The union, however, of Bodies with Water, in this way, is merely mechanical, and cannot properly be called a chemical combination. Whether this ever occurs in Springs, in sufficient degree to bring

them under our Term, *Mineral*, admits of a doubt. Some circumstances, to be mentioned hereafter, incline me to favour the opinion that it does so. It is certainly possible, and seemingly not unlikely to happen with respect to some bodies, though as yet we have very few instances adduced in proof of it. Bodies are likewise capable of being united together in another manner, in which, certain of their original properties are, on their junction, destroyed, and new ones produced in the compound, different from what either of the component parts were before possessed of. This method, the modern Chemists have distinguished by the name of *Chemical Mixture*. We are not certain, however, that this ever occurs in Mineral Waters. Some circumstances would lead to a distant suspicion of it, but we have scarcely sufficient grounds on which we can build even a probable supposition.

I would not, however, by this be understood to say, that no compound substance of this nature is to be found in Mineral Waters. On the contrary, when the subject comes to be examined, it will be found

found that simple substances, properly so called, make but a very small part of the Catalogue of these Impregnations. I only mean to comprehend those, wherein the substances, united with the Water, may be said to form with it a chemical mixture.

The most general, therefore, and, indeed, I may almost say, universal method by which Mineral Waters become impregnated, is by *Solution*. As this word is here taken in a somewhat more confined sense than its common acceptation, and, in some measure, in contradistinction to the two foregoing, viz. *Diffusion* and *Mixture*, it will be proper to give some previous explanation of the sense in which I propose to make use of it.

When a solid body immersed in a fluid is divided by it, and uniformly dispersed, suspended, and retained in it, it is said to be dissolved, and the operation is called *Solution*. This is the general sense, but it may be extended to the union of two fluids together. The body to be dissolved is called the *Solvent*, and the fluid which dissolves it the *Solvent*, or *menstruum*. In *Solution*, the parts of the *Solvent* are so

intimately and equally applied to the Solvent, that in the most minute portion of the one, there is part of the other present. This mode of union differs from the two foregoing in several instances. Those, however, which are most applicable to our purpose, are the following.

It differs from Diffusion, in that the latter, as we generally meet with it, is only temporary, and the diffused body, on its standing some time unmoved, falls to the bottom.

N. B. This sometimes happens in solution, but then it is always in consequence of some decomposition of the dissolved substance, which is not the case in the precipitation which takes place in diffusion.

The body that is diffused, will not pass a filtre with the fluid in which it is diffused.

When a solid body is diffused through a fluid, the latter is never perfectly clear. This, however, is not always discoverable by the naked eye, but may at all times be found out by microscopical examination.

From

From *Mixture* it differs, that in solution there is no change of qualities, but only the Solvents turning fluid, whereas in mixture, a neutral, or tertium quid, is always produced.

In solution, more than two bodies may be joined together, but only two in mixture.

In solution, likewise, nearly the same degree of heat serves to volatilize the body as when separate, which is not the case in mixture. These are the principal distinctions between these modes of combination of bodies with Water. Others, indeed, might be mentioned, but I think these sufficient to answer my purposes here.

But in order to determine accurately all the possible Impregnations of Waters, I shall take a view of the different forms of bodies, and by examination of each, according to the propositions before laid down, endeavour to judge, from thence, of the probability of their being met with in a search of this kind.

As to my division of Bodies, I propose to make use of that laid down by the celebrated Professor at Edinburgh, as before-

mentioned, being the most concise, extensive, and clear, of any yet published.

A compleat division of this kind, that will include all the Bodies in Nature, is not to be expected; however, most Bodies, some few excepted, of little consequence to my present purpose, may be reduced to the five following heads, viz.

1. Saline.
2. Inflammable.
3. Metallic.
4. Earthy.
5. Aërial.

CHAP.

C H A P. III.

Of SALINE MINERAL WATERS in
general.

THE first of these that occurs to our observation, is * *Saline Bodies.*

An universal characteristic of these substances is Solubility in Water. They vary, indeed, considerably from each other in the proportion in which they dissolve, in-somuch, that some have denied the solubility of some of them altogether.

It is now, however, incontestibly proved, that they all possess this quality in some degree. From this general property we

* Saline bodies are such as, when applied to the tongue, give the sensation of Taste, and are soluble in Water. Some have added, that they are fusible in the fire, and not inflammable, without the addition of some other substance. These qualities, however, are now generally rejected, as not holding universally, since some saline substances cannot be fused by the most vehement force of fire we can apply; and others are found to be of themselves inflammable. There is, however, some reason to believe, that the latter of these qualities is owing to some small portion of inflammable matter accidentally mixed with it.

might expect to see them often make a part of the impregnations of Mineral Waters; and indeed few springs have been discovered entirely free from some degree of a saline quality. Notwithstanding, however, this general solubility, what was laid down in the first proposition must be attended to, that only such as are native fossile substances can be admitted. From inattention to this circumstance, and neglect or ignorance of the proper methods of distinguishing them from each other, many supposed discoveries have been made of certain saline substances in Mineral Waters which our reasoning *a priori*, might have informed us we could never expect to meet with there, and which a more accurate examination has detected to be only mistakes of these for some other native saline substance resembling them. Great caution is, however, requisite in laying down general rules with respect to this class of bodies, as some very slight alterations in the manner of their production are capable of making great difference in the nature of the Salt produced.

I shall

I shall now proceed to speak of particular * Saline Substances, beginning with the Simple, and proceeding on to the Compound. I do not mean to include the Metallic and Earthy Salts under the latter head, as those shall be separately treated of when I come to speak of Metallic and Earthy Substances.

Division
of Saline
Mineral
Waters
into sim-
ple and
com-
pound,

Of MINERAL WATERS *impregnated with*
SIMPLE SALINE SUBSTANCES.

I shall take the simple Saline Substances as nearly as possible in their order of strength, beginning with the Acids.

Section I.

* Saline bodies are either *simple* or *compound*. By *simple* saline bodies, I do not mean to assert, that they are absolutely so, but only that they are bodies which we have never yet resolved, or separated into their component parts, in opposition to the *compound*, whose constituent parts we are acquainted with. Simple saline bodies are either *Acids* or *Alkalies*. An Acid is a saline body of a sour taste, and possesses the particular property of changing vegetable juices that are blue to a red colour. Acids are distinguished into four kinds, according to the substances from which they are got, *viz.* I. *Vitriolic*, as being used to be got from a substance called Vitriol. II. *Nitrous*, from Nitre. III. *Muriatic*, from Muria, or Sea Salt. IV. *Vegetable*, from Vegetables. *N. B.* There is reason to think, that there are other kinds of Acids distinct from these. But their nature and properties are not yet sufficiently ascertained.

Among

Of MINERAL WATERS *impregnated*
acids

Among these the Vitriolic Acid claims the first place*. *vit: acid*

Whether this substance, in its separate state, has ever been found a native fossil, has long been the subject of much doubt among the natural Philosophers. To ascertain this point would be a matter of great consequence; as, were this fully

* The Vitriolic is the most powerful of all the Acids, dislodging all the others from Alkaline Salts, both fixed and volatile, and from the soluble Earths, and taking possession of them itself in their place. It is likewise capable of being rendered the most concentrated, in which state it is the strongest of all the Acids, containing the largest quantity of pure Acid in proportion to the phlegm or water. It is found in two states, a fixed, and a volatile one, the former of which is now meant. When concentrated to the highest degree we generally arrive at, its specific gravity is nearly as $18\frac{10}{7}$ to 10 of water, which is considerably more ponderous than any other fluid we are acquainted with except quicksilver. It is perfectly fluid, colourless, inodorous, and transparent, when pure, contrary to what † Neumann alleges, and its assuming an icy or butyraceous consistence in the cold, as well as its brown colour, is now found to be owing to a portion of inflammable matter mixed with it. As to its properties with regard to other bodies: When joined with the other Acids it effervesces, and generates heat with them. It unites also with all the Alkalies attended with heat, and when they are in a crystallized or mild state, with a large discharge of air, and ebullition, called Effervescence. It unites also with oily bodies of all kinds, with heat, effervescence, and fumes. It is capable of being united with ardent spirits, or alcohol, and with the latter forms the substance called Æther. It does not unite

† Neumann's Chemistry, p. 161.

with

proved, we could then have no doubt of the possibility of its being found in Mineral Waters, on account of its strong attraction to, and easy and intimate union with, water; insomuch that, when most concentrated, it always retains a portion of this substance. The notion of the presence of an acid in springs is of antient date, and at last came to be applied to all

with sulphur. It unites with all the metals except gold, and even that is doubtful. It dissolves zinc and iron, only when in a dilute state, and copper when rather more concentrated: The remainder of the metals it only acts on in a boiling heat, which, on cooling, are precipitated in a corroded state. It unites with all the absorbent earths, and with them forms different saline compounds. It joins water very easily, and with it, in a fluid form, generates heat in the greatest degree of any of the Acids, but when converted into ice, it generates cold with it. It attracts water from the atmosphere, and, as some think, unites with mephitic air. It prevents or obstructs all the three kinds of fermentation, and is, therefore, antiseptic. I before observed, that this Acid is sometimes got in a volatile state, in which it is strongly odorous. It is gained in this manner from all inflammable bodies, with which it is united by nature or art. In this state less acid saturates more alkali, but any of the other three Acids dislodges it from it, or decomposes the neutral salt formed by it, as does the fixt vitriolic Acid. Its action on oily matters is inconsiderable, probably on account of its diluteness. It produces no æther with alcohol. It dissolves metals in larger proportion than the fixt. It unites also with earths. It generates less heat with water, and less cold with ice, than the fixed.—If the reader is desirous to see a more particular account of this substance, he may consult *Neumann's Chemistry*.

the

the Mineral Waters that were not possessed of some sensible degree of heat. Was any credit to be given to these opinions, the Acid of which I am now treating should seem, on many accounts, the most likely to be found in this manner. On examination, however, of the grounds on which they were founded, there is reason to believe, that this, though the possibility of it cannot absolutely be denied, happens in much fewer instances than has commonly been imagined. The chief arguments that have been made use of in support of the possibility of its being found in Mineral Waters, are deduced from the following circumstances :

1. The universality of its presence through Nature.

It has been the opinion of some Chemists, that this Acid was generally distributed through every part of the natural kingdom ; that it was plentifully dispersed through the subterraneous regions, and even present in the atmosphere.

Was this fully ascertained, it would undoubtedly be a strong argument in favour of
of

of this opinion. The proofs, however, are, some of them, very equivocal. The chief are the following :

It has been alledged, that the fixt vegetable alkali, exposed to the air, melts per deliquium, and crytallizes again into a salt, resembling vitriolate tartar. But there are no proofs of its actually being so, and vitriolate tartar and vegetable alkali crytallize in the same form. It has likewise been urged, in favour of this opinion, that silks exposed to the air have their colour changed, and metals rust, and are corroded ; but neutral and alkaline salts corrode these as well as acids, and it is not impossible that a neutral salt may suffer a * decomposition by the joint action of the silks, or metals, and the air. Though this be no more than conjecture, it is useful to prevent our forming rash conclusions, by pointing out the possibility of a fallacy in

* By decomposition is meant the resolution (or separation of the component parts) of a compound. Thus Nitre, for instance, which is a saline body, composed of the nitrous acid, and a vegetable alkali, is decomposed by the addition of the fixed vitriolic acid, which attracts the vegetable alkali more powerfully than the nitrous acid does, and thereby separates it from the nitrous acid.

such cases. It must, nevertheless, be owned, that there is one very strong instance of its universality, viz. its being constantly present in the electrical fluid, which is generally diffused over Nature. This is evident from the sulphureous smell, which is always perceived during electrical experiments, and is the odour of the volatile vitriolic acid. Moreover, if the wire be brought from the gun-barrel to a person's tongue, who stands on a cake of resin, it gives no shock, but has an evidently acid taste.

The conical flame, likewise, which issues from the barrel, when brought within a certain distance, has the same effect with acids on the vegetable blues.

The supposition of its existence in the air, has procured it a name by which it is frequently distinguished, *Sal acidum vagum universale*. On this account the vitriolic acid has been supposed floating in the bowels of the earth, and not without great appearance of reason, because of the quantity that exists there, as is universally acknowledged, in a compound state; and that many of the substances that contain it
are

are liable to decomposition, in which case it would be volatile. The deleterious vapours in mines, which are said to hurt or destroy animal life, in the same way with the vitriolic acid, have been brought in confirmation of this argument.

In answer to this, however, it may be alledged, that there are so many bodies in the bowels of the earth that it attracts, that it could not remain permanently in form of a vapour, as, on being decomposed, it would associate with them; that there are other vapours very different from the vitriolic acid, that destroy or hurt animal life. The inflammable vapours in mines have been likewise brought as another proof; but these can only be adduced as instances of the vitriolic acid in composition, and not even evident proofs of that, as the muriatic acid emits an inflammable vapour likewise, during the dissolution of iron.

It is, however, said, that there are actual proofs of the existence of this acid in some Waters, as is manifest by their pungent, acid taste, and by their changing the colour of the vegetable blues. Though these facts seem to conclude strongly in favour

vour of the opinion of the existence of this acid, yet I cannot, nevertheless, think them quite satisfactory.

Some compound salts, as alum, change vegetable blues to red ; and fixed air, when accumulated in large quantity in water, gives it a degree of pungency not easily distinguishable from an acid. It is likewise confidently alledged of the last-mentioned substance, that it has the same effect with acids on vegetable blues.

Nor does it seem at all improbable, that a substance of the same kind with that discharged from metals, during their solution in acids, which an ingenious Writer supposes to be their phlogiston in a separate state, may be contained in some Waters. This has not, I own, been yet suspected, though it is evident, from the inflammable damps before-mentioned, that a vapour of this kind discharged from iron, is frequently accumulated, in great quantity, in the bowels of the earth ; and I see no objection against the possibility of its sometimes being intermixed and carried along with the current of a spring. But as this appears always in form of a vapour, I shall
treat

treat of it more fully when I come to speak of *Aërial Bodies*.

An ingenious Author has given us great reason to think, that the Phlogiston itself is not a simple substance, but a compound of an acid and fixible air. If this theory be just, it will easily account for the similarity of effects between this substance and the Vitriolic Acid. If experiments are to be trusted to, the same effects are in some degree attributed to it. I shall speak more largely of this substance when I come to treat of *Aërial Bodies*.

Notwithstanding what has been said, and though I am fully satisfied that this Acid has frequently been mistaken for some other substance, I dare not assert that this is always the case. We have accounts from the best authority, of Mineral Waters which shewed such evident marks of acidity* as to remove all doubts on this head concerning that quality.

In support of this opinion likewise, a plausible theory has been alledged. It is

* Varenus mentions a fountain in the Province of Noto, in Sicily, which was used instead of Vinegar. *Monro on Mineral Waters*, vol. i. page 16.

well known that Pyrites, and even sulphur* itself, especially when they are moistened, are liable to deliquescence and decomposition. This might easily happen in the bowels of the earth, by the current of a stream interfering with any beds of these substances; and if this decomposition should take place not far distant from the surface, it might impregnate the spring before it be prevented by any fresh attraction.

This theory, however, is liable to several objections.

It is found in general, that neither Pyrites nor Sulphur suffer any spontaneous decomposition, except in circumstances where the air has access, which could not often be the case in the bowels of the earth.

This happens very rarely, except in consequence of some large subterraneous caverns, where coal, or metal have been

* This may be illustrated by a familiar instance. Flowers of sulphur are well known to contract by keeping an acidulous taste, owing to the phlogiston in part flying off *per se*, and leaving the acid separate; and for this reason the London College directs them to be washed in warm water before they are used, in order to clear them of their superabundant acid.

dug, and where the air has a communication by which it may be carried off; being, when separated from the sulphur, in a volatile state. Therefore in this instance it cannot be properly esteemed a pure fossile.

This argument, though it carries some weight with it, cannot be admitted to conclude satisfactorily against what has been urged. That this sometimes happens in the forementioned cases, is easily granted; but we must, on the other hand, allow, that very large * fissures of the earth, and subterraneous caverns, are not always artificial, but sometimes formed by nature, and very frequently by those accidents, which, though, as has been before said, are interruptions of its course, still make a part of Natural History.

Of this kind are earthquakes, volcanoes, subterraneous fires, &c. which we know by experience, frequently have this effect.

Thus the ground in the neighbourhood of several volcanoes is found to be hollow

* Dr. Monro, on this subject, quotes *Dominicus Vandellius de thermis Agri Patavini*, pag. 95. who relates an account of the native vitriolic acid falling by drops in a native cavern near Latera.

to a considerable distance, and probably it is owing to this circumstance, that the waters in the neighbourhood of these often possess this quality in a high degree.

It is probable, likewise, as an ingenious Author has suggested, that in cases where the fore-mentioned circumstances occur, “* that the subterraneous fire, in decomposing the sulphureous Mineral Bodies by which it is principally fed, disengages a large portion of the Vitriolic Acid in the neighbourhood of these fountains, which may afterwards interfere, and unite with their current.”

This is undoubtedly another possible method by which we may account for the presence of this substance in Mineral Waters. This, however, happens in fewer instances than might be expected, as the attractions of this substance are so general and so potent, as to prevent its remaining long unassociated, except in some† peculiar circumstances.

* *Mouro on Mineral Waters.*

† Some have imagined chalybeate waters might be impregnated with an acid, in the interval of its separation from the iron, and its dissipation in the air.

On the whole, then, though with some restrictions, it must be allowed, that the Vitriolic Acid *per se** may sometimes make a part of the impregnations of Mineral Waters†.

NITROUS ACID.

The next substance that occurs in order, is the Nitrous Acid‡. The Natural Hif-

Nitrous
Acid.

* Although I am inclined to believe, that the vitriolic acid, when found native *per se*, is never in a perfectly fixed state, yet it certainly possesses various degrees of volatility, as is evident by its sometimes changing the colour of vegetable blues to a reddish cast; whereas, when this acid is perfectly volatile, it destroys all colour whatever.

† I have been informed, by the learned Dr. Wall, that he had some reason to suspect an impregnation of this kind in Malvern Water.

‡ The nitrous acid is more powerful, and may be obtained in a more concentrated state, than any of the other acids excepting the vitriolic. Its specific gravity, when most concentrated, is to water as 15 to 10. In the state we generally see it, it is of a reddish brown colour, and emits a strong fume, or vapour, though it loses this latter quality, in a great measure, on re-distillation with water, and when pure, is perfectly colourless, and transparent. It unites with all the acids, and generates heat with them. Its union with the marine produces a compound, called *Aqua Regia*. It joins the alkaline salts with the same general phenomena as the vitriolic acid does; but more of it is requisite to saturate a given quantity of alkali, than of the vitriolic. It attracts the alkali more strongly than either of the two following acids. It unites with oils of all kinds, effervesces, and strikes a black colour with them. It likewise generates more heat with them than the vitriolic does, and this is so great as sometimes to produce inflammation. It generates heat, fumes, and effervescence with ardent spirits, but never breaks out into actual flame. There is a kind of

tory of this is not so well ascertained as that of the Vitriolic Acid, so that I cannot speak of it so fully. The generality of later Chemists have been agreed, that this is never in its simple state a native substance. Its proper matrix seems to be the upper part of the soil, or staple of the earth, where vegetables grow, and where it is deposited in great quantity, but always in a compound state, united with an Alkaline Salt. It has not been found, even in this state, in any fossil substance, as we cannot reckon Nitre as such. For some accounts of the latter being found in trifling quantity at a considerable depth in the earth, prove no more than that it is sometimes washed down from the surface*. Nevertheless, an ingenious Writer of the

Æther produced by this combination. It does not act on sulphur. It unites with all the metals except gold. It dissolves and suspends all but antimony and tin, which are only corroded by it. It unites with all the absorbent earths, and produces with them earthy salts. It generates heat with water, but not in so great a degree as the vitriolic acid, but produces more cold with ice or snow. It attracts water also from the atmosphere, but not so powerfully as the vitriolic acid. It inflames on the contact of burning charcoal, and is attended with detonation and explosion, and is thus the foundation of gunpowder.

* The *saline neutral* seems to be the only one of the six forms of bodies, to which it is united by nature.

present

present age has mentioned the nitrous acid *per se*, as the predominant impregnation in most of the waters he examined. I would willingly pay all due deference to the authority and judgment of this learned Gentleman, but as he has not recited the methods he took in detecting and ascertaining this substance, cannot help suspecting it to be either a mistake of this for the volatile vitriolic acid, which, in some respects, such as its decomposition by the fixt vitriolic acid, its exhaling a powerful odour, &c. much resembles the nitrous, or else the decomposition of some substance used in the experiment, containing the nitrous acid.

The late ingenious Professor of Chemistry at Edinburgh has made many experiments to this purpose, but could never discover the least trace of any impregnation of this kind. In order to ascertain this, I have likewise myself added a fixt vegetable alkaline salt to a great number of pump waters, but never could discover the smallest particle of nitre on evaporation, which must have been the case

had the water contained the nitrous acid in substance.

It would not, however, be proper to deny, from any reasoning *à priori*, the existence of a fact supported by so great an authority as the author of the foregoing observation. It will not, however, I hope, be esteemed presumption, to suggest a thought, which perhaps may reconcile both these opinions. The spring water of London, which was the subject of the above-mentioned experiments, was, as the author observes, liable to many impurities from cellars, burying-grounds, sewers, and other offensive places, &c. with which they undoubtedly often communicate.

From our accounts of the production of nitre, I should imagine it owed its origin to putrefaction, as it is said to be gained in largest quantity by a lixiviation of those earths, which have had the greatest proportion of animal or vegetable substances left to putrefy in them.

Since the introduction of the manufactory of Nitre into Europe, the substance procured on washing the earth is found to
be

be a * nitrous ammoniac, or the nitrous acid combined with a volatile alkali, which is changed into Nitre by lixiviating it with pot ashes. This seems very probable, as the volatile alkali is always copiously gene-

* That there should be so great a difference between the operation of nature in the East Indies and Europe, as that a common Nitre should be produced in the one, and in the other a nitrous ammoniac, seems very extraordinary. But the accounts that we have hitherto received of the making of Nitre in Asia are from inaccurate and injudicious observers, so that we may readily suppose them imperfect. The late ingenious Professor of Chemistry at Edinburgh mentioned a fact, the probability of which inclined him to form an opinion that cleared up all the difficulties on this subject. It is this: That in Asia they burn a number of vegetables on the place where they want to produce Nitre, and leave their ashes to have their alkali washed in by the rains, which will infallibly decompose the nitrous ammoniac, and form a Nitre in the earth which will now be got by simple lixiviation. Is it not extremely probable, that those who have given an account of this matter, have neglected the inflammation of the vegetables, considering it as merely designed to free the earth from them? Nay, perhaps, the inhabitants may have no other intention. I have been since informed by Sir J. Pringle, that in some parts of Germany a true Nitre is gained by a simple lixiviation of the earth, and this would seem to contradict the above opinion. But when we consider the circumstances attending the method in which it is procured, this difficulty will, in a great measure, be got over. The earth used for this purpose is made up nearly altogether of the filth and rakings of the town streets, and as wood is the constant fuel burnt there, it is probable that considerable quantities of the ashes must be thrown out, as we see in many small towns in England, and thus intermixed with the earth used for the above mentioned purpose. This, it is obvious, would supply an alkaline basis of the vegetable kind, and thus with the nitrous acid form a true Nitre.

rated

rated during putrefaction; but there is no reason to think this to be the case with the fixt. This is moreover confirmed by a circumstance, which the Author of the above work afterwards relates, *viz.* that a certain spring in the city never fails to yield a portion of volatile alkali on distillation, which is always the product of putrefaction, and probably owing to some animal substances, with which it is tainted in its passage under ground. From what has been above related it seems probable, that some of the wells, which this ingenious Gentleman examined, might contain the nitrous ammoniac. If then any fixt alkaline substance was used in making the experiment, this would be decomposed, a degree of * effervescence would take place, and a nitrous salt would be left on evaporation, in the same manner as if the nitrous acid had been present in the water uncombined with any other body. It is possible, likewise, to suppose a method, by

* In this case the volatile alkali, when separated from the nitrous acid, being in a caustic state, would absorb part of the fixt air separated from the fixt alkali, on its union with the acid. Nevertheless, as the fixt alkali contains fixt air in larger proportion than the volatile, some effervescence would take place from the superabundant portion.

which

which a spring might be impregnated with the nitrous acid in its separate state. Should any of the springs, which contain the nitrous ammoniac, communicate with any other, which, from some of the substances above-mentioned, contained the vitriolic acid in a separate state, a decomposition would take place, by which the nitrous acid might be disengaged from the volatile alkali, and thus left by itself diffused through the water.

Here, however, another difficulty occurs; the vitriolic acid is always found, when native, in some measure in a volatile state, in which it will not decompose any neutral salt formed by the other acids. To this, however, it may be replied, that the volatile vitriolic acid, on being largely diluted with water, is in part restored to its fixt state, which may serve to account for this appearance*. There is, indeed, one cir-

* This seems true with respect to the volatile vitriolic acid *per se*, but will not hold of it when united with iron, as in that case it seems to be entirely dissipated on its communication with the atmosphere. This metal seems to possess a power of rendering even the fixt vitriolic acid in some degree volatile, as we see in solutions of green vitriol, which, on standing exposed to the air, suffer a decomposition, owing to the acids flying off, which occasions the precipitation of the iron in a flaky ochrous form.

cumstance,

cumstance, which would seem to argue strongly in favour of the notion of the nitrous acids being sometimes found in the earth, united with vegetable or animal substances, in a state of putrefaction, as common garden mold yields it by simple distillation. Now Nitre, although it fuses both in open and close vessels, cannot be decomposed without the addition of some other body. Mr. Pott, of Berlin, has nevertheless lately shewn, that if a fine sand be added to the Nitre to keep its parts separate, and prevent its fusion, that this acid will rise in distillation, and come over pure into the receiver. This was, indeed, an old practice, but it was then thought an elective attraction took place, which Mr. Pott shews not to be true. It seems, therefore, very probable, that the particles of the soil here perform the part of the sand in the other case, in preventing the fusion of the Nitre, and occasioning the rise of the acid*. But the strongest reason of

* As Nitre is easily decomposed by the addition of heat, and any body that contains the phlogiston, it may be thought that this takes place here, as a quantity of inflammable matter is always found in earth in this state. There is reason, indeed, to think this does not take place except where the air has access, which would not be the case here.

all to induce us to believe, that the nitrous acid is never found native, is, that the smallest portion of cubic Nitre was never yet discovered in any analysis of springs. As common salt is accumulated in so large quantity in the earth, it must be often changed into cubic Nitre, was the nitrous acid present there in its separate state.

The possibility of it, however, can scarce be denied, as it is supported by so good authority. Granting, even the facts were as there represented, as the causes that produce it are obvious, and the circumstances in which it happens, accidental, it can scarce be properly accounted a native impregnation.

MURIATIC ACID.

The general opinion of the Chemists with respect to this acid, has been the same as that last mentioned, viz. that it is never found in the earth native in its separate state. When combined with the fossil

Muriatic
Acid.

* This acid is less powerful, and cannot be got in so concentrated a form as either of the two foregoing. Its specific gravity, when most so, is to water as 12 to 10. It is generally got in a fuming state, but may be deprived of that quality in the same manner with the nitrous acid. Its colour, when most concentrated, is generally a gold yellow. It unites with the other acids with heat and effervescence. It joins an alkali, as they do likewise, but requires

alkali, in form of common alimentary salt, it is the most frequent impregnation we meet with; but I have not, till lately, met with any Writer who has mentioned this substance combined, as being present in any Mineral Waters. Nevertheless, the ingenious Author of the foregoing observations of the existence of the nitrous acid alone in springs, has made the same remark with regard to the muriatic. The same objection, however, still subsists, *viz.* that he has not related the experiments by which he ascertains the truth of his assertion.

It is possible, however, to account for this, in the same manner as the foregoing. Should any of the springs, which, from any of the above-mentioned circumstances, contain the vitriolic acid uncombined, interfere with any that contained common salt, the muriatic acid would be set loose in the same manner as the nitrous, in the

requires more of it for saturation. It does not unite with oils or sulphur, and but imperfectly with ardent spirits. It acts on all metalline substances except gold. Zinc, iron, and copper are dissolved by it, as likewise in some circumstances, mercury and antimony. It only corrodes silver, lead, and bismuth. It unites with absorbent earths, and with the calcarious forms the combination called Fixed Ammoniac.

preceding

preceding instances. Indeed it seems a great argument against the existence of the vitriolic acid in substance in the earth, that this decomposition of common salt, which is so plentifully distributed through the subterraneous regions, does not oftner occur, since this is the first instance I have heard of.

VEGETABLE ACID.

All Writers seem to be agreed, that this acid*, in any of its forms, either simple, or in combination, has never been found a fossile substance, and, of consequence, could

Vegetable
Acid.

* This is of three kinds, one got by expression from the cells of vegetables, particularly acid fruits, in which it is prepared by nature, as juice of lemons; another got by distillation, as the acid of the fir, or pine; and a third, which is the product of the acetous fermentation; and even of this last there are two varieties; viz. vinegar and tartar. The general properties of the vegetable acid are to unite with all the other acids, as also with alkalies, only with less effervescence. Its force of attracting them is also less. Its specific gravity differs little from water. It does not unite with sulphur or oils, though it has, when in a very concentrated state, some effect on ardent spirits. Of the metals it dissolves zink, iron, copper, and lead; and extracts an emetic quality from antimony. It dissolves several of the other metals also, when previously dissolved in other acids, and precipitated by an alkali, and some of them are rendered soluble in it by calcination, and others by mere trituration, as mercury. It unites with absorbent earths, and, when highly concentrated, generates some degree of heat with water. It absorbs no moisture from the atmosphere, as the others do.

never

never impregnate a Mineral Water. Some have imagined the acid salt procurable from amber was of this kind, but experience has shewn it to have different properties. It is probable that there are other acids, besides the four already treated of. We have not, however, the least reason to believe that any of them were ever found impregnating a Mineral Water.

ALKALIES.

lies.

Having finished what I had to say on the first division of simple saline bodies, I shall now proceed to the second, *viz.* Alkalies*.

* An alkali (besides the properties common to saline bodies) in the state we generally see it, effervesces when joined to an acid, that is, we perceive an intestine motion excited, attended with many air bubbles, and a hissing noise. It has moreover the property of changing the vegetable blues green. The property of effervescence is not essential to alkalies, but owing to their union with a substance called fixible or mephitic air, and when deprived of this, they lose that quality. Alkalies are of two kinds:

I. Fixed.

II. Volatile.

The fixt alkali comprehends two species, the

1. Vegetable.

2. Fossile.

The volatile alkali contains one species only.

The properties common to both species of fixt alkalies are, that they cannot be dissipated but by the most extreme heat, and that they emit no odour when applied to the nostrils.

The volatile alkali is dissipated by the slightest degree of heat, and emits a remarkable pungent odour.

In

In treating of these I cannot follow the order before laid down with respect to the Acids, to take them in their order of strength, as it is not yet determined whether the vegetable or the fossil alkali have the strongest attraction to acids. As, however, the natural history of the vegetable alkali is best known, I shall begin with that, and proceed, in order, to the fossil and the volatile alkali, which last is the weakest of any.

FIXT. VEGETABLE ALKALI*.

The vegetable fixt alkali does not appear to be a native substance, either in its

Fixt Vegetable Alkali.

* The Vegetable Alkali has a peculiar taste, more or less acrid as it is more or less caustic. It is often described as of an urinous flavour, or that of the volatile alkali. This, however, does not proceed from it, but from an ammoniacal salt contained in the saliva, which is decomposed by it. When pure, it is of a snow white colour, and perfectly inodorous. It concretes, when perfectly mild, into regular crystals, of an hexagonal prismatic form, terminating in a pyramid at both ends. When in the smallest degree caustic, it attracts moisture from the air, and runs per deliquium. It will not unite with the fossil alkali, though the one so much resembles the other. It joins all the acids, and forms,

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with

pure state, or as united with other bodies. It was formerly thought to be present in vegetables, from whence some have inferred the possibility of its being a fossil substance. In proof of this some facts have been alledged, but these are far from being conclusive, as it never appears in them before inflammation, during which, in any vegetable substance, it is always copiously

with each of them, neutral salts. It attracts acids more strongly than the volatile alkali, metals, or earths. Both this and the fossil alkali seem to have nearly the same force of attraction. It unites with oils of all kinds, and, with them, forms different soaps; but this union seems confined to its caustic state, in which, also, it will unite with ardent spirits. It unites with sulphur, and forms with it a compound soluble in water, called *hepar sulphuris*. It dissolves copper, lead, and iron in their metallic state, and acts on all the rest, when precipitated from their acid menstruums. It promotes their fusion greatly, and unites also with them in this way. It dissolves some of the animal earths, as the calculus of urine, and in fusion joins all the pure earths, and, when so united, forms glass. It generates heat with water when caustic, and the more that quality predominates, the greater is the heat. In this state, likewise, it dissolves universally animal and vegetable substances. When mild, and in a crystallized form, it produces cold. By long boiling it is altered in its nature, part of it being converted into an absorbent earth. It checks fermentations of all kinds, and is, therefore, antiseptic.

gene-

generated. From what has been above said, it should seem, that we can never expect to meet with this substance present in any Mineral Water; and, indeed, all facts seem universally to confirm this opinion, as no Author has asserted that it has been ever found in its separate state in any Mineral Water. There have been, indeed, some suspicions that it sometimes appears there in a compound state, which I shall speak of when I come to treat of Compound Saline Bodies.

Dr. Percival has, indeed, very ingeniously suggested to me, that the vegetable alkali may sometimes be washed down in sufficient quantity to impregnate a running water. If we give credit to the accounts of large woods being set on fire by lightning, and burnt down, any spring rising near them might thus receive their ashes, as washed down into it by the rains; which ashes, as was before said, contained the vegetable alkali very copiously; the possibility of the fact cannot be denied; and it must be likewise owned, that though

it is, in some degree, accidental, yet the circumstance producing it happens in the course of nature, so that we cannot deny it to be a native impregnation. It does not, however, as has been before observed, appear from any accounts, that we have any facts to prove that this has ever happened; and, indeed, I am inclined to believe, that if it were to take place, it could be only temporary, and, moreover, destitute of that equal degree of impregnation at all times, which so eminently characterise the generality of the native Mineral Waters.

FOSSILE ALKALI.

Fossile
Alkali.

* It was the opinion of the antient Chemists, that Mineral Waters were always

* The fossile alkali agrees nearly with the vegetable in the sensible qualities of taste, colour, and odour, but varies greatly in regard to its consistence; assuming a solid form with great ease, and so far from attracting moisture from the air, that it becomes drier, and has its crystals covered with a mealy powder. It unites with acids with less effervescence

impregnated with an acid, either in its separate state, or in combination with other bodies : But Drs. Stahl and Hoffman have since shewn, that they sometimes contain the fossile alkali, unmixed with any other substance. That it exists in large quantity in the earth, is well known from the quantity of native saline substances that contain it, the fossile alkali forming the alkaline basis of Glauber's salt, and common salt, both which, (the latter, indeed, more particularly,) we know to be native fossile substances. I have likewise been informed, by several accurate and judicious observers, in particular the learned Doctor Wall, of Worcester, that this substance, in its separate state, has been discovered in several Waters in Great Britain *.

cence than the vegetable, and forms different neutrals. Its force of attraction, and effects on other bodies, seem exactly the same, so that it forms a soap with oils, hepar sulphuris with sulphur, glass with earths, &c.

* It is proper to observe, that the fossile alkali, when native, is always in a mild state, though it is capable of being rendered caustic, in the same manner as the vegetable.

VOLATILE ALKALI.

Volatile
Alkali.

It has been a great matter of dispute, if ever the fossile kingdom affords this substance native*. Some circumstances would lead us to favour such an opinion. Many stones have been found, which, when broken, and the inner parts rubbed strongly against each other, give out an odour resembling the volatile alkali, from whence their name has been taken, viz, *Lapis Suillus*.

It is likewise undoubtedly found in some plants, particularly those of the acrid kind.

* This substance differs in appearance, as it is mild or caustic, being in the first case easily crystallized, but in the second, always in a fluid form, because (on account of its volatility, which is much greater when caustic) it cannot be rendered solid by force of fire. It forms different neutrals with all the acids. It does not unite with oils when mild, and very imperfectly when caustic, nor with ardent spirits. With sulphur it forms a *hepar sulphuris*; it unites with such metals as the fixed alkali does, both in solution and precipitation. With copper, or its solution, it strikes a beautiful blue colour. It does not unite with earths in the way of fusion, probably on account of its volatility, but dissolves the calculus of urine. When mild, it generates cold with water, and when caustic, heat.

It

It was formerly thought it was not discoverable in them before a degree of putrefaction had begun to take place, but though it is then greatly increased, as it is always copiously generated during that process, there is reason to believe, that it existed in the plant before that began to take place. From hence it has been inferred, that it is sometimes of fossile production. The former of these circumstances, indeed, seem to argue strongly in favour of that opinion. The ingenious Professor at Edinburgh, nevertheless, accounts for this from some vegetable or animal substances being washed down in a state of putrefaction, and these concretions forming round them. Whether this opinion be just, or no, is of small consequence to the present question, as it is always here in a state of too firm concretion to be washed out by water, and therefore could never by these means impregnate a spring.

As to its being found in vegetables, it is probably formed there by some peculiar process during vegetation, and not absorbed from the earth; though even granting that

it were so, it could only be in consequence of the putrefactive process, which is constantly going forward in the upper part of the earth where vegetables grow, and which never descends so deep as to be capable of impregnating a running water with any substance produced in consequence of it.

In great cities, indeed, where large quantities of putrefying substances are necessarily accumulated, and the sewers placed at a considerable depth in the earth, it is not improbable that they may often interfere with the current of springs, and impart to them some degree of a volatile alkaline impregnation.

An instance of this was above related, as mentioned by Dr. Heberden.

As, however, the circumstances in which this happens cannot fairly be ascribed to Nature, it cannot, in this instance, be accounted a native impregnation.

There is, however, one circumstance which seems to support the possibility of its being so.

Sal ammoniac has been sometimes found a fossile substance, as adhering to the lava
of

of volcanoes, where it is produced by inflammation, during which it is often copiously generated.

It has been found sometimes likewise in this country in fissures of the earth, from whence the smoak of burning coal pits issues. Should this be again washed down into the earth, and interfere with any spring containing the fossile alkali, a decomposition would ensue, a common salt would be formed, and the volatile alkali left by itself combined with the water.

This case is certainly possible, but I have seen no experiments adduced in proof of it.

Henckel, indeed, in his *Bethesda Portuosa*, tells us, that he found a volatile alkali in several waters on distillation, but in his experiments he formed an hepar sulphuris, and the fixed alkali, when decomposed from thence, appears in a volatile form.

As hepar sulphuris is so commonly found a fossile substance, were we certain of the presence of an unneutralized acid in the bowels of the earth, there would then be
less

less doubts concerning the possibility of this impregnation, as the hepar sulphuris is decomposed by every acid, and the saline compound formed in consequence of it, might be again decomposed by the fossile alkali, as in the manner before related.

This, however, is but barely possible, and withal requires such a combination of circumstances as we can scarce expect to occur in the same instance.

In a word, though the possibility of the volatile alkali making a part of the impregnation of Mineral Waters cannot be absolutely denied from any reasoning *a priori*, yet for the reasons before given, and as its existence there is not supported by any facts, it can scarce be accounted a native impregnation of Mineral Waters.

S E C T. II.

Of MINERAL WATERS impregnated with
COMPOUND SALINE SUBSTANCES.

HAVING finished what I had to say Sect. II.
of simple saline substances, I now proceed
to the compound *.

And here the Reader is again desired
to take notice, that I mean to confine
this term, which is often used in a larger
signification, to the neutral salts only, as
the metallic and earthy shall be treated
of separately, when I come to speak of
metallic and earthy substances.

I shall take these in the order † they
stand in the annexed table; the first of
these that occurs is vitriolate tartar.

* Compound saline bodies are formed by the union of
the first simple saline body, *viz.* an acid with such substances
as by that union produce a third body, which possesses
the characteristics of the saline class; these are either the
other simple saline substance, *viz.* an alkali, or else metallic,
or earthy bodies, so that compound saline bodies are of
three kinds, *viz.*

- I. Neutral, composed of an acid and an alkali.
- II. Metallic, of an acid and a metal, generally, though other
saline substances are capable of reducing them into a
saline state.
- III. Earthy, of an acid and an earth.

† It has been before observed, that a neutral salt was
formed by the combination of the two simple salts, *viz.* an
acid

VITRIOLATE TARTAR*.

Vitriolate
Tartar.

This compound salt is generally imagined not to be a native substance. It is said to

acid with an alkali, which can be only united together in certain proportions. As there are four of the former of these, and three of the latter, it is evident that these can only be formed into twelve combinations; the different names of these are set down in the ensuing table. In the first column are placed the four acids, opposite each of these the three alkalies, and thirdly, three sets of salts opposed to each acid.

A TABLE of NEUTRAL SALTS.

Acid.	Alkali	Vegetable	Vitriolate Tartar.
I. Vitriolic.	fixt	Fossile	Glauber's Salt.
	Volatile		Vitriolic Ammoniac.
II. Nitrous.	Fixt	Vegetable	Common Nitre.
	Volatile	Fossile	Cubic Nitre.
			Nitrous Ammoniac.
III. Muriatic.	Fixt	Vegetable	Digestive Salt.
	Volatile	Fossile	Common Salt.
			Common Ammoniac.
IV. Vegetable.	Fixt	Vegetable	Sal Diureticus, vel Tartarus regeneratus.
	Volatile	Fossile	Sal Polychrestum Rupellense.
			Vegetable Ammoniac, or Sp. Myndereri.

* Vitriolate tartar, when carefully crystallized, assumes the form of six sided pyramids in its crystals, which are of an hard concretion, and more difficult solution than any neutral salt we are acquainted with, requiring near thirty times its weight of water, to render it fluid in the common temperature of our atmosphere. It is of so difficult fusibility, that in our furnaces we are not able to fuse it. When heated to a certain degree, it decrepitates, that is, makes

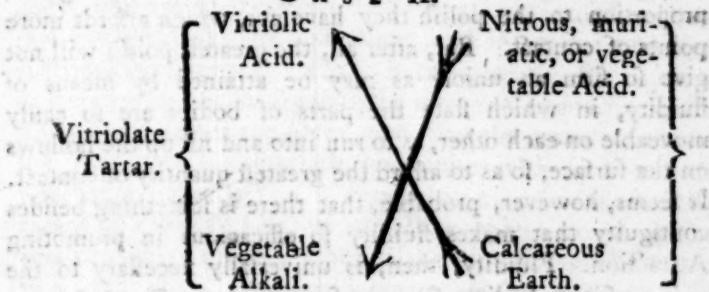
be found, indeed, in the ashes of some plants, but is there probably produced by

makes a crackling noise in consequence of the rarefaction of the water contained in its crystals. It may be decomposed by addition of the phlogiston, which forms with it an hepar sulphuris, by adding solutions of calcareous earth, magnesia, or any of the metals, in any of the other acids. In the three last mentioned cases, however, a double elective attraction always takes place, as in the annexed schemes.

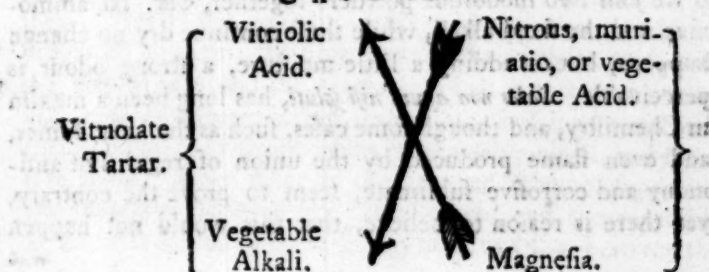
CASE I.



CASE II.



CASE III.



As

the inflammation. This fact, however, is much to be doubted, as the vegetable

As the term *Electric Attraction* will frequently occur in the course of the work, and as it is here used in a peculiar sense, the Author has subjoined the following explanation of it.

The combination of bodies depends on that inclination or tendency which they have to approach to each other, and, in certain circumstances, to remain coherent. To this general fact, the English Philosophers have given the name of *Attraction*. This, however, is not meant to express a primary principle, but as Sir Isaac Newton, who first brought the term into general use, employed it to express a general fact. There are four kinds of this known, *viz.* The Attraction of Gravitation, of Magnetism, of Electricity, and of Cohesion; and it is thought, that on this last kind the combination of bodies depends, though that seems very doubtful. However, before this takes place, the two bodies must be so near, as to be apparently in contact, and the more points of contact that are presented the stronger is the union. Thus two hemispheres of lead will remain coherent on pressing together their plain surfaces, and their union will be the stronger in proportion to the polish they have got, which affords more points of contact. But, after all, the greatest polish will not give so firm an union as may be attained by means of fluidity, in which state the parts of bodies are so easily moveable on each other, as to run into and fill up the hollows on the surface, so as to afford the greatest quantity of contact. It seems, however, probable, that there is something besides contiguity that makes fluidity so efficacious in promoting Attraction. Fluidity, then, is universally necessary to the union of two bodies, so as to form a mixt. For instance; if we join two inodorous powders together, *viz.* sal ammoniac and the fixed alkali, while these continue dry no change happens, but on adding a little moisture, a strong odour is perceivable. *Salēs non agunt nisi soluti*, has long been a maxim in Chemistry, and though some cases, such as the heat, fumes, and even flame produced by the union of regulus of antimony and corrosive sublimate, seem to prove the contrary, yet there is reason to believe, that this would not happen

was

alkali and vitriolate tartar crystallize in the same form, which might give occa-

was not a quantity of moisture absorbed from the air. This, however, may be laid down, that fluidity in one of the bodies is necessary for combination. The same degree of Attraction, however, does not subsist between all bodies; there are some which refuse to combine with one, and yet unite with another. Thus water unites with nitre but not with camphor; and spirits of wine unite with camphor and not with nitre. This is what is called *Elective Attraction*, and is either absolute, as in these two cases, or relative, when a body unites with another, but will leave it if a third be presented, because there is a stronger attraction between this new body and it. Thus silver and gold may be united together; but if the nitrous acid be presented, the silver joins it, and leaves the gold. Elective attractions may be also considered as either single or double. There is always a new combination takes place in elective attraction, and when there is but one, this is called *single*, that is, when a single or simple body is used to make the separation. But when a body, which is itself composed of two others, is used to separate two bodies; two separations, and in general two new combinations happen. Thus, if the muriatic acid, united to mercury be used to separate the nitrous acid and silver, the nitrous acid leaves the silver, and joins the mercury, and at the same time the muriatic acid unites with the silver. It sometimes happens that a separation may be effected by means of a double Elective Attraction, which could not be produced by a single. Thus if the vitriolic acid be joined to a fixed alkali, they have a greater affinity, or stronger attraction to each other, than any single body has to either of them. But if the solution of silver in the nitrous acid be presented to them, the silver attracts the vitriolic acid, and the nitrous acid and the vegetable alkali attract each other, and these two forces acting in opposite directions, overcome the union of the vitriolic acid and vegetable alkali, and separate them. Thus if, as in the annexed scheme, supposing the attraction between the vitriolic acid and the vegetable alkali be supposed to be as twenty-five, and that between the
nitrous

sion to the mistake of them for one another. Whether this be so or not, there

nitrous acid and the silver to be as five; the compound of these, *viz.* twenty five, may be considered as the power that keeps them in their present situation. But if the attraction between the nitrous acid and the vegetable alkali be as eighteen, and that between the vitriolic acid, and silver be as twelve, the aggregate of these will be thirty, which is superior to the former, and must of consequence work a separation which neither of the two substances singly would have effected.

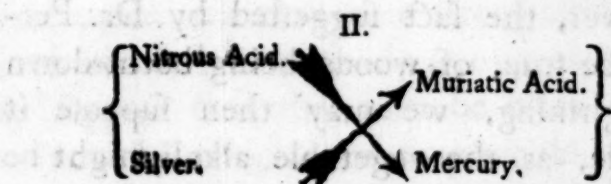


The darts are meant to express the stronger attraction of the body from whence the feather proceeds, to that to which the point is directed, than the body with which it was then joined. Thus, in the above case, the silver attracts the vitriolic acid stronger than it does the nitrous, with which it was united; and the nitrous attracts the vegetable alkali stronger than it does silver. In this case the position of the darts could not be altered, as, were the points placed in a direction from the vitriolic acid to the silver, and from the vegetable alkali to the nitrous acid, it would denote, that the vitriolic acid attracted silver stronger than the fixt alkali; and that the alkali attracted the nitrous acid stronger than it did the vitriolic, which is not true. In some cases, the position of the darts may be varied, as thus:



II. Ni-

is not the least reason to think, either from our accounts of facts or theory, that this



This may be further varied; but this is sufficient. In some cases of decomposition of compound substances by compound ones, only one new compound is formed. This is the case in the curdling of soap, so frequently observed in our spring waters. In this case the darts are put side by side. Thus:



Here the calcareous earth or quick-lime does not unite with the oil. The same thing happens in chalybeates. Thus:



In forming schemes of this kind on paper, we should be careful to place the solvent body uppermost. In general, where we can place the darts with both their points either upwards or downwards, we may be pretty certain that a decomposition will take place, but where they can only be placed laterally, or side by side, (the last case especially,) it is more uncertain. In many cases where the darts are placed either upwards or downwards, they may be likewise placed laterally; but the converse does not hold, as some

Of MINERAL WATERS impregnated

was ever found a native fossile, since one of its component parts, the vegetable alkali, is confessedly an artificial substance. If, however, the fact suggested by Dr. Percival be true, of woods being burnt down by lightning, we may then suppose it possible, as the vegetable alkali might be washed down by the rains and impregnate a spring, and, as its attraction to the vitriolic acid is stronger than any metallic or earthy substances, it would decompose all the earthy or metallic salts it might meet with, and with their acid, which is always the vitriolic, form a vitriolate tartar. I cannot, however, admit this, even in these circumstances, to be a native impregnation for the reasons before given, in speaking of the vegetable alkali. On the whole, then, we may safely reject this substance from the number of impregnations of Mineral Waters.

some cannot be varied from their lateral position to both the darts upwards, or both downwards, and it is these cases which are here meant. In order to make this more clear, a Table of Elective Attractions, with an Explanation, is added at the end of this Book.

GLAU-

GLAUBER'S SALT*.

As I have before mentioned that the two compound parts of this salt are fossile substances, which bear a strong affinity to each other, it is certainly not unreasonable to suppose that they may be often found united, in which case they would form a Glauber's salt. The probability of this will appear stronger when we consider the place the fossile alkali holds in the Table of Elective Attractions, with respect to the

Glauber's
Salt.

* The form of the crystals of Glauber's salt is that of a six sided prism. It differs, however, in this respect from the foregoing, in that its crystals are much larger, and have their ends obtusely truncated; whereas the others end in a pyramid. They are likewise of a very loose contexture, as containing more water than those of any other neutral salt whatever. It is of the easiest and most plentiful solubility of any neutral salt known. It is remarkable to observe here the changes that happen to bodies in composition. The vitriolic acid, and the vegetable alkali, (in its caustic state, in which it always is when it forms a neutral,) attract water strongly when separate, and readily unite with it. Nevertheless, these two, when combined, form a neutral, (*viz.* vitriolate tartar,) which is of the most difficult solution of any salt of that (neutral) kind. On the other hand, the fossile alkali, which makes the alkaline basis of Glauber's salt, is not deliquescent, (or liquefiable in the air,) and seems to have much less attraction to water; and yet Glauber's salt is of much easier solution. It fuses easily in the fire, and is said to have some great effects upon metals, but these are not ascertained. It can be decomposed only in the manner in which vitriolate tartar is decomposed.

vitriolic acid; the latter attracting the fossile alkali stronger than any other native substance known, the phlogiston excepted; and even with respect to this there are some doubts. Experience likewise confirms the foregoing theory; and we have undoubted proofs, that this salt has been found native in the earth, and, on account of its easy solution in water, may make an impregnation of a mineral one, and indeed it is in this state it has been generally found.

Its appearance, however, in the earth is not so frequent as has been imagined, another substance which resembles it, and which shall be mentioned hereafter, having been often mistaken for it. It is, however, certainly sometimes a native impregnation of Mineral Waters.

VITRIOLIC AMMONIAC*.

Vitriolic
Ammoniac.

From what has been said concerning the volatile alkali's not being a native fossile

* This substance is easily got in hard dry crystals, which do not deliquesce, and are of difficult solution in water. It may be formed from various combinations, more, indeed, than any of the other ammoniacal salts, as its acid has a stronger force of attraction. It may be decomposed by the fixed alkali, or by forming it into an *bepar sulphuris*, and adding any of the other acids to it.

sub-

substance, it should seem probable, that this likewise, which has the volatile alkali for one of its component parts, should be also rejected from the catalogue of native impregnations. Experience likewise seems to favour this opinion; as no Writer, that I know of, has asserted, that this substance has been ever discovered in any Mineral Water*.

I have, however, some doubts if we can safely deny the possibility of its sometimes making a part of their impregnation. It has been before observed, that sal ammoniac was produced by inflammation, and that by this means it has been found native in the clefts and fissures of the earth in the neighbourhood of volcanoes and subterraneous fires. That the vitriolic acid likewise had been found native in the neighbouring springs, being separated by the force of fire from the pyrites.

Should, therefore, any of the springs, thus impregnated, have the sal ammoniac, formed as above, washed down into it, a

* Hoffman seems to hint, that a salt of this kind was sometimes found in the neighbourhood of volcanoes; but his meaning is not very clear. See vol. iii. p. 138. § xxxix.

decomposition would ensue, the vitriolic acid uniting with the volatile alkali of the sal ammoniac, and forming with it a vitriolic ammoniac. To this it may be objected, that the vitriolic acid is then in its volatile state, in which it will not decompose any of the neutral salts.

This objection is in part true, as we have great reason to believe, that the vitriolic acid is separated by fire from sulphur in that state.

We know, however, by experience, that if the communication with the air be obstructed, which seems likely to be the case in subterraneous fires, it soon becomes fixed when diluted with water. A proof that this sometimes actually happens in these cases is, that these springs are said to change the vegetable blues to a red, whereas the volatile vitriolic acid discharges entirely all vegetable colours whatever. It is not therefore impossible, that some of the springs in the neighbourhood of volcanoes, burning coal-pits, and other subterraneous fires, might, if examined, be found containing a portion of this substance.

As

As I have not, however, had any opportunity of making the experiment, and as I before acknowledged no Author has mentioned it as actually discovered, what has been said above must be considered only as theory that bears some appearance of probability. I cannot, therefore, reject this substance from the catalogue of possible impregnations of Mineral Waters.

We now come to the second arrangement of Neutral Salts, *viz.* those which have the Nitrous Acid in their composition. The first of these that occurs in order is common Nitre.

COMMON NITRE*.

I mentioned before, in the account of the Nitrous Acid, that it was never found

Common
Nitre.

* The crystals of Nitre neither melt, *per deliquium*, in a moist, nor calcine in a dry air. Their form is that of a six sided prism; and, when very perfect, terminate, at one end, in a pyramid of so many sides. It is of a middle solubility, between Glauber's salt and Vitriolate tartar; but the different temperature of its menstruum makes a greater difference in its solubility, than any of the neutral salts. It is of easy fusion in the fire. By application of the phlogiston it may be decomposed without going first into the form of an *hepar sulphuris*. Hale's Experiments shew, that it contains much fixed air, which, during its deflagration, is rarified, and explodes with violence; and hence is the foundation of exploding mixtures, particularly gunpowder.

a native fossile, either *per se*, or in composition. Some traces, indeed, of a nitrous salt are said to be found in some waters; but there is reason to believe, that it was accidentally washed down from the surface, where (in the putrefying soil) it is copiously generated. On this account, and as its alkaline basis is always an artificial substance, it can by no means be admitted as a native impregnation of springs.

CUBIC NITRE*.

Cubic
Nitre.

By what has been before said, concerning the nitrous acid, it appears, that this salt can never be found native in Mineral Waters.

No Author that I have met with has ever asserted it; though, if the nitrous acid were ever in its separate state in the bowels of the earth, it must be frequently formed, as common salt is contained, in some degree, in every spring hitherto discovered, and its alkaline basis bearing a stronger

* Cubic Nitre agrees nearly altogether with Nitre in its properties, and differs only in the form of its crystals, which are, like Nitre, six sided; but these sides are of a rhomboidal figure.

affinity

affinity with the nitrous acid, than with the muriatic with which it was united, the common salt would be decomposed, and a Cubic Nitre formed in its place.

Did this ever happen it would account for the presence of the muriatic acid alone in springs, as asserted by some Writers, though on scarce sufficient foundation.

As, however, its alkaline basis is confessedly a native substance, both in its separate state and in composition, it should not seem unlikely, that Cubic Nitre might be met with in many of the springs in great cities, where, by communicating with putrefying bodies, they may have received an impregnation from the nitrous acid or nitrous ammoniac. Impregnations, however, of this kind, as happening only in accidental circumstances, and being produced by means evidently artificial, cannot be admitted into the catalogue. In consequence of this, therefore, Cubic Nitre must be excluded.

NITROUS

NITROUS AMMONIAC*.

Nitrous
Ammo-
niac.

From what has been before said concerning the nitrous acid and the volatile alkali, the two component parts of this salt, we may conclude, that the Nitrous Ammoniac can never, except in circumstances that cannot fairly be ascribed to Nature, be found native in springs. It is, in all probability, never produced except in consequence of † putrefaction, which was before-mentioned, as not taking place at a sufficient depth in the earth to impregnate a running water. For a further explanation of this, the Reader may look back to what has been said concerning the Nitrous Acid, the Volatile Alkali, and Nitre.

The next order of Salts is of those which have the muriatic acid in their composition, the first of which is Digestive Salt.

* The Nitrous Ammoniac assumes a less solid concretion than the Vitriolic, or even common Ammoniac. It is very deliquescent, and dissolves easily in spirits of wine. Its most remarkable property is, that it inflames, and explodes *per se*, which shews how difficult it is to assume a general characteristic of bodies, since this contradicts that generally given of saline substances.

† Some have imagined, though on no very good grounds, that the Nitrous Ammoniac is sometimes produced during the inflammation of burning bodies. If this be the case,
it

DIGESTIVE SALT*.

This is easily determined not to be a native substance, the Vegetable Alkali having been before proved not to be found below the surface of the earth. Granting, however, that it should be so accidentally, as in the case before-mentioned, of woods being set on fire by lightning, this salt could not be formed, as the muriatic acid is never found a native fossile, except when combined with the fossil alkali in form of common salt, which is not decomposed by the Vegetable Alkali. It may therefore be safely excluded from the catalogue of Impregnations of Mineral Waters.

Digestive
Salt.

COMMON SALT†.

This is well known to be a fossile substance, existing in great quantity in the

Common
Salt.

it might be possibly found in springs which rise in the neighbourhood of volcanoes, or subterraneous fires, such as were mentioned in speaking of the vitriolic acid.

* This substance resembles common salt in most respects. Its crystals are cubical, like those of common salt, and can be got firm and solid much more easily. Some Chemists have fancied that there was some other difference, but their proofs are not satisfactory. More will be known of its qualities when we come to speak of common salt.

† This is too well known to need much description, so shall only mention a few of its characteristic marks. The form

earth, and so common an impregnation of springs, that scarce any have been discovered entirely divested of some traces of this quality. It is found native in the earth in much larger quantity than any other saline body that we know of. It is likewise more universally dispersed, though very unequally so. In consequence of this, we meet with many more degrees of this impregnation than of any other saline substance, it being found from quantities imperceptible to the senses, to that of a saturated solution. In this state it is, I believe, always pure, though in the state we get it, there is almost always a superabundant portion of absorbent earth adhering to it, but this is owing entirely to the heat used in the boiling necessary for the crystallization; part of the acid being dissipated, and the alkali changed in some degree into an absorbent earth. If the crystalli-

form of its crystals, when carefully made, is that of an exact cube. In the fire it decrepitates like vitriolate tartar. It dissolves in two thirds its weight of water, and in equal quantity, whether the water be cold or hot. It is not so fusible as nitre, or so refractory as vitriolate tartar. It may be decomposed by force of fire, with addition of any inflammable substance, or, in general, by elective attraction. It is antiseptic, but in what proportion is unknown.

zation,

zation, however, be performed with a moderate degree of heat, and stopt in proper time, the salt may be got perfectly pure. We may therefore conclude, that it is in this state that it exists in springs.

SAL AMMONIAC*.

It was long thought that this was a native substance, but this opinion is now found to be erroneous. It has been already mentioned that it was sometimes found in the neighbourhood of volcanoes, and other subterraneous fires, and chiefly in the cracks and fissures from whence the smoak issues; many instances of this are to be found in Britain.

Sal Am-
moniac.

In this situation, therefore, it might undoubtedly be washed down by the rains,

* The crystals of sal ammoniac are in form of a star. Those that I have seen had four points; but some have asserted, that they have six points. It deliquesces in moist air, but readily assumes a concrete form. It requires thrice its weight of water to dissolve it. It dissolves in alcohol, and fuses in a gentle heat, in which it rises entire in flowers, without any decomposition, for which reason it is purified by sublimation. Its being found native in the neighbourhood of burning mountains, &c. has induced an ingenious Chemist to think, that all the acids are convertible by inflammation into the muriatic.

and

and impregnate any stream it might meet with. I have, however, before given it as my opinion, that this would not constitute a native impregnation; it cannot, therefore, be received into our catalogue as such.

We now come to the last arrangement of neutral salts, *viz.* of those compounded with the vegetable acid.

REGENERATED TARTAR.

+ Regene-
rated Tar-
tar.

The first of these that occurs, is regenerated Tartar.

From what has been before said concerning the component parts of this salt, it may be easily inferred that it never is, nor can be found native.

The vegetable acid, though a natural production in the way of vegetation, is never found below the surface of the earth, and the vegetable alkali, the other component part, is not, in any respect, a native substance.

SALT OF ROCHELLE.

* Salt of
Rochelle.

The next in order is the salt of Rochelle, which may be excluded on the same account

+ *Vid: Serrat.*

* *Vid: Serrat.*

count as the last mentioned, since although its alkaline basis is a native fossile body, yet as the vegetable acid is not so, they can never be found native in combination; on this account, therefore, it must be excluded.

VEGETABLE AMMONIAC.

The last in the catalogue of the neutral salts is the Vegetable Ammoniac, commonly called Spiritus Myndereri.

Vegetable +
Ammo-
niac.

For the reasons before given in speaking of the two foregoing substances, it will be easy to see the reasons which must exclude this likewise.

From what has been said, we find that the following are the only proper saline substances that can be expected to be found native in any Mineral Water.

Simple. Acid { Vitriolic acid per se.

Alkali { Fossile Alkali per se
 { Volatile Alkali very dubious

Compound { Glauber's salt
 { Vitriolic Ammoniac very dubious
 { Common salt

{ Sal Ammoniac very dubious.

+ Vid: Ennat.

C H A P.

C H A P. IV.

*Of MINERAL WATERS impregnated
with inflammable Substances*.*

Division
of inflam-
mable
substances.

THE ingenious Author, whose division of bodies has been chosen for the plan of this Work, has arranged inflammable substances under three heads, viz. *Oil, Sulphur, and Ardent Spirits.* From the presence of one of these in their composition, it has been said that all bodies derived their inflammability.

There seems to be, however, great reason to believe, that to these might be

* A body is called inflammable when, on the contact of a burning substance, it catches fire immediately in the part touching that substance from whence the fire is propagated over the whole mass, till all of it, or the greatest part, is entirely consumed, and the rest reduced to ashes. During this a luminous vapour, called flame, floats on the surface of the burning body. Some have denied this last circumstance to be an universal mark of burning bodies, as charcoal has the fire propagated from a small part of it over the whole, which, undoubtedly, gives it a place among inflammable bodies, yet emits no flame from its surface. It is found, however, now, that a stream of air blowing on charcoal will cause it to flame like other inflammable substances.

added

added an inflammable vapour, or air; some, indeed, have thought that this differed only from oils, or ardent spirits, as the vapour of water does from liquid water.

There seems to be good reason for believing that an inflammable air exists, which is permanently in that state. But as this differs so much in its form from other inflammable substances, it shall be treated of under the head of Aërial Bodies.

I shall treat of the foregoing inflammable substances in the order they are placed above. The first of these is

S E C T. I.

O I L*.

Oils are divided into vegetable, animal, and fossile, and the two first are again subdivided into expressed, essential, and empyreumatic.

Oils, vegetable, animal, and fossile.

* Oil is defined to be an inflammable fluid, and not miscible with water, without the mediation of some other substance. All inflammable bodies were some time thought to owe their inflammability to an oil which they contained, because there is some appearance of oil in ardent spirits, and sulphur consists of vitriolic acid, and some inflammable matter, which was supposed to be an oil. This notion is, however, now doubted, though they still attribute the inflammability of all three to one common principle, which differs in its nature from any of them.

H

This

VEGETABLE and ANIMAL OILS *not*
found native in MINERAL WATERS.

Vegetable
and ani-
mal oils
not found
native in
Mineral
Waters.

It is very obvious, that no oil of the vegetable, or animal kind, can be ever found a fossile substance, and, indeed, there is reason to believe, that if any quantity

This principle has never been shewn by itself, and, indeed, is rather imagined than known; though, indeed, there is very great probability in favour of its existence. It is called in Chemical books, the Phlogiston.

Expressed oils are so called from their being contained in certain cells of animal and vegetable substances, and being produced by breaking down these cells by pressure. They are of a mild bland taste, have no peculiar odour, and are not miscible with ardent spirits. Wax and fat belong to this class.

Essential oils have an acrid taste, and remarkable odour, which is the same with that of the substance from which they are got. From their being supposed to contain the active part, or essence, of the bodies from which they were extracted, they have got the name of Essential. They are sometimes, though improperly, called Distilled Oils, as they may be got often by simple expression only, as in the rinds of some fruits, as oranges and lemons. M'quer has confined essential oils to the vegetable class. But musk and castor, though procured from animals, are essential oils. Balsams and resins likewise belong to them. They all dissolve in spirits of wine, in which they differ from expressed oils.

Empyreumatic oils are acrid to the taste, and strongly odorous, but their odour is much the same from whatever substance they are got, and seems to be acquired by the application of a certain degree of heat, from which they have derived their name. They dissolve easily in spirits of wine. Tar belongs to this class.

of

of either of these should be by any artificial means introduced into the earth, that it would there be changed in its nature, and acquire the properties of the fossile oil.

In consequence of this, they must be excluded from the catalogue of native impregnations of Mineral Waters: And this opinion seems fully confirmed by experience, as there does not seem to be any traces of any substance of this kind discoverable from the analysis of any water hitherto examined.

The only native substance then of this kind found below the surface of the earth, is the fossile oil.

FOSSILE OIL, *per se*.

This is plentifully deposited in many parts of the subterraneous kingdom, and, though under different forms, owing to the admixture of other bodies, is originally of one species only.

Fossile Oil
per se.

When in its utmost purity, it is perfectly thin and transparent, of a peculiar, yet not disagreeable odour, and acrid taste. In this state, however, it is very rarely seen

Of MINERAL WATERS impregnated

native. Its most common form is to be of the consistence of a balsam, and of a brown colour. It is sometimes found in both these states, flowing out from the earth by itself, or joined with Water, but more frequently the latter. In its separate state, of which I am now speaking, it does not admit of an intimate, or, properly speaking, a chemical union with Water, by solution or mixture, but only of diffusion through the body of it.

This, however, is often so minute, as to have the same appearance, and exert like effects with a chemical combination.

From the vast quantities of this substance that have been discovered below the earth, we might expect to see it more frequently in springs. The cause of this seems to be, that it is mostly in a very impure state, and united with substances which render it of a hard consistence.

When thus combined, it is in a state of too firm concretion to be united with Water, which, as has been before observed, can only admit of an union with it in the way of diffusion.

Thus

Thus we see springs flow through numerous beds of pit coal, yet do not receive from them any impregnation of this kind. As, however, there are unquestionable proofs of its being sometimes found native in a fluid form, and as several springs have been discovered containing it in its separate state, it must undoubtedly be ranked in the catalogue of native impregnations.

FOSFILE OIL in a saponaceous form.

It has been before remarked to be a quality of alkalies to unite oils with water in form of soap. As the fossile alkali is confessedly found native below the surface of the earth in its separate state, it is possible to suppose that by this means the fossile oil might be combined with Mineral Waters, in a more intimate manner than by that last mentioned, of simple diffusion.

Fossile Oil
in a saponaceous
form.

There seems to be, however, some objection to this, viz. that alkaline salts possess this quality only in their caustic state, which does not appear to be the case with the fossile alkali, as that, when found

H 3 native

Of MINERAL WATERS impregnated

native in a solid form, is generally crystallized, which is commonly accounted a mark that an alkaline salt is in a mild state, or saturated with fixt air.

From the easy crystallization of the fossile alkali from the Mineral Waters that contain it, we may suppose that it is contained in them in a mild state likewise. But it has been of late discovered, that crystallization is not so certain a criterion of the mildness of alkaline salts, as has hitherto been imagined.

It seems a true one, indeed, with respect to the vegetable alkali, but is by no means so of the fossile and volatile alkali, which will crystallize when in some degree caustic. It does not seem improbable that it may be in this state in Mineral Waters, and if so, would undoubtedly contribute to the more intimate union of them with any oily substance.

This conjecture seems more probable, as there is very good authority for asserting the existence of Mineral Waters of this kind, though the instances are very few.

It

It must therefore be admitted into the catalogue of native impregnations.

S E C T. II.

S U L P H U R.

Whether Sulphur ever makes a part of the native impregnations of Mineral Water, has long been a matter of great dispute among the Writers on this subject. Sulphur.

As the point is of some consequence, and has been both combated and supported in an able manner, I shall lay before the Reader the sum of the arguments on both sides, which have been well collected by the ingenious Dr. D. Monro, and subjoin afterwards some observations of my own relative to this point.

First, then, it has been alledged, in support of the opinion, that Sulphur is a native impregnation of Mineral Waters :

* That the foetid smell of some waters resembling Sulphur, is certainly not owing

* *Philosophical Transactions*, Vol. LI. Art. 28.

to mere stagnation, and a consequent putrefaction, as many of them have a brisk current.

Secondly, That putrid rain water, and many chalybeates turned putrid by keeping, do not discolour metals; neither do they cure cutaneous disorders, as many of those waters called sulphurous do.

Thirdly, That the smell, flavour, and effects of some waters, and of their vapours, in discovering metals, are perfectly similar to those produced by the artificial solutions of Sulphur and of its vapours.

Fourthly, That many waters, called sulphurous, contain the native fossile alkaline salt, which is capable of dissolving, and keeping suspended, a small portion of Sulphur.

Fifthly, That a milkiness, or incipient precipitation, is produced in several of those waters by dropping acids into them.

Sixthly, That a white heavy mucus is commonly precipitated on the sticks or grass over which such waters pass; and that at several fountains this mucus burns blue

blue and smells of Sulphur, and that true yellow flowers of Sulphur have been got by sublimation from the mud precipitated from some of them.

Seventhly, That a true and real Sulphur has been found floating in some cold sulphureous waters.

Such are the principal arguments hitherto employed to prove the existence of Sulphur in Mineral Waters.

In answer to these it has been alledged, that Sulphur can be dissolved in water only by means of an alkaline salt, which gives the water a yellow colour, and on addition of acids an hepar sulphuris is precipitated.

But it is said, speaking of Aix la Chapelle Waters, that these waters are clear and colourless, and that mineral acids preserve ~~its~~ pellucidity, and prevent its becoming milky and dropping a sediment.

Secondly, That the waters themselves are not capable of dissolving either their own or an artificial Sulphur.

Thirdly, That as to the Sulphur found adhering to the pipes through which the water

water flows, it does not proceed from the waters containing the Sulphur substantially dissolved in them, but on account of their being impregnated with a phlogiston and an acid, the principles of Sulphur, which being in a volatile state are sublimed, meet on the surface of the conduits, and there unite into a true and perfect Sulphur, which did not naturally exist in the water; and likewise, that part of this Sulphur, falling back again into the water, is precipitated to the bottom, which gives the mud a black colour and other sulphureous properties.

That the foetid smell, and property of tinging metals, which many of the cold waters called sulphureous have, are entirely owing to their containing an oily matter, and undergoing putrefaction, which all waters are subject to, and that on trial none have given any clear and certain proofs of their containing Sulphur.

That the flowers of Sulphur, alledged to have been obtained by sublimation from the mud of some of these waters, were generated by the force of fire, subliming and incorporating the phlogiston and vitriolic acid,

acid, which were not before intimately united together in the waters.

These are the principal arguments which have been made use of by the most eminent Writers on both sides.

And here I cannot help observing, that the use of the term Sulphur, in an indefinite sense, has occasioned much confusion, it having been applied to that substance in its proper form, and to the several forms of hepar sulphuris. These it is of consequence to distinguish, as sulphur thus united acquires different properties from any it possessed in its simple state; and moreover, the different kinds of hepar sulphuris are endued with qualities varying one from the other, as I shall soon have occasion to observe.

To remedy this inconvenience, therefore, whenever Sulphur is mentioned in the ensuing Work, I desire it may be understood of Sulphur in its proper form, or not combined with any body that changes its nature.

I propose then to consider, first, Simple Sulphur as an ingredient in the composition

*O*f MINERAL WATERS *impregnated*
 fitid of Mineral Waters; and afterwards
 the two varieties of *hepar sulphuris*.

SULPHUR *per se*.

Sulphur
per se.

This substance is undoubtedly found
 native in the earth sometimes, though
 rarely, in pure bright yellow semi-trans-
 parent masses, but more commonly in
 opaque ones, of a greenish, greyish, or other
 colours, intermixed with earthy and stony
 matters. But the principal matrix of
 Sulphur is the ferruginous ore, called,
 from its colour and striking fire with steel,
Yellow pyrites.

As the proportion of Sulphur here is
 very large, it appears to contain a con-
 siderable quantity in its native form, and
 this seems to be the case with several
 others of the metallic ores.

But in this state Sulphur is totally in-
 soluble * in water, and may, therefore, be

• EXPERIMENT I.

Two drachms of washed flowers of sulphur were added
 to eight ounces of distilled water, heated to 120 degrees.
 They were suffered to stand four hours together, in a close
 vessel, and then filtered off. The liquor had not the least
 taste

with INFLAMMABLE SUBSTANCES.

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safely rejected, in its dissolved state, from the catalogue of native impregnations.

Notwithstanding these arguments, I am inclined to believe, that Sulphur, in its pure and unmixed state, makes a part of the composition of several Mineral Waters. In those of Aix la Chapelle, for instance, it is found pure, and in large quantity, daily separating from them; and though a great Writer, whose argument on this head has been lately mentioned, has attempted to elude the force of this circumstance; yet I apprehend, his reasoning, though ingenious, is scarce satisfactory.

I have been credibly informed, that at Aix la Chapelle the Sulphur is not only found on the surfaces of the reservoirs and conduits, which lie above the water, and into which it sublimes, but that the pipes, through which it runs, are uniformly lined on all sides with Sulphur strongly adhering

taste or smell of sulphur, nor did any precipitation happen on adding a solution of saccharum saturni in water.

EXPERIMENT II.

A lump of yellow pyrites, previously washed, was boiled an hour in two pounds of distilled water, without imparting the least sulphureous impregnation that could be discovered.

to

to them, and of an equal thickness, resembling much more a gradual precipitation from the water, than (as he says) pieces that have accidentally dropped in from the places into which it had sublimed.

He himself allows, that the waters contain the component parts of Sulphur, *viz.* an acid, and the principle of inflammability, and as these two attract each other more strongly than any other body, what reason can be given why they may not be supposed to unite when intimately applied to each other, as floating in the same fluid, as well as when sublimed together from it?

But, by his own account, sublimation is not necessary to unite them, since he afterwards tells us, that these waters, drank for some time, give a sulphureous smell to the whole body, tinge the patient's linen of a yellow colour, and even tarnish and turn black silver carried in the pocket.

The ingenious Dr. Monro has observed, likewise, that these waters cure the itch, or other cutaneous disorders, in the same manner as Sulphur, which is no quality of either of its component parts when separate. The same learned Author has mentioned several

several instances, from good authority, of Sulphur being so largely contained in some waters so as to be got by evaporation.

It seems most likely to suppose, that in these waters the sulphur is suspended by means of a subtile diffusion. Were it dissolved in them by means of an alkali, it would manifest itself by its taste and smell, resembling a rotten egg, or scowring of a foul gun barrel; yet some of these waters, though they have a sulphureous taste and smell, are yet very distinguishable from that of the *hepar sulphuris*. Add to this, that the waters impregnated with *hepar sulphuris* do not spontaneously deposit their sulphur in the manner those of Aix la Chapelle do, and when strong shew a precipitation on addition of acids, which is not the case with those containing simple sulphur. The like argument will hold against their impregnation with sulphur by means of quick-lime, as it does not easily separate when thus dissolved; and moreover sulphur seems to be contained in some waters in larger proportion than could be done by these means. If, therefore, it be admitted that sulphur may be contained in
a Mine-

a Mineral Water in a diffused state, it will rationally account for the spontaneous precipitation of it from them, as at Aix la Chapelle, and will obviate the objections drawn from chemical experiments, such as its not being precipitated by acids, &c. as in this state it is not in the least affected by them. To this, perhaps, it may be objected, that although it cannot be denied that sulphur is sometimes found native in the earth, yet that it is then either in a hard compact form of crystals, or united with other substances, which give it a still firmer concretion, as in the case of pyrites, in either of which states it seems very unlikely to be carried along with a current of water, and for a time at least suspended in it, which would require the most minute division possible of its parts. To this, however, it may be replied, that most of the springs in which there is reason to believe Sulphur is contained in this state, are of the thermal kind, and which probably owe that quality to some subterraneous fire adjacent to the current of their stream, as it rises to the surface. It is well known, that Sulphur, when air is excluded, may be sublimed by mere force of fire, from
pyrites

pyrites in its pure state in form of flowers. It is not unlikely, then, that Sulphur may be thus accumulated in some subterraneous caverns, too deep for our researches, into which it may have been sublimed, and thus intermix with the current of a spring passing through it. This will account for its being thus contained in the water, as in the form of flowers it is the most minutely subdivided possible, and of consequence the most likely to be carried along with a stream of water.

The ingenious Mr. Macbride has, by an experiment of his, suggested a method, by which a spring may be impregnated with Sulphur, in its pure state, in the way of solution.

He made a solution of Sulphur in Water by means of quick lime, and by injecting currents of fixt air upon the surface of it, found the calcareous earth to precipitate, leaving the Sulphur dissolved in the Water. I shall speak of this more largely when I come to treat of Waters impregnated with hep. sulph. cum calce vivâ, but shall observe here, that, granting the fact, it does not appear to be the case in all Waters that

tain pure Sulphur, as some of them seem to contain it more plentifully than could be done by this means; and moreover, by Mr. Macbride's own account, the Sulphur thus dissolved, does not spontaneously precipitate as it does from some of the Sulphureous Waters.

I am, therefore, though not without some degree of doubt, inclined to admit Sulphur in this form into the catalogue of native impregnations.

HEPAR SULPHURIS *with an* ALKALI.

Hepar
sulphuris,
with an
Alkali.

There is not the least doubt that this is frequently found native in springs. Its smell and taste are so discernible, as to leave no room for a mistake of this for any other substance.

Moreover, the blueish white precipitation, which several of them give on addition of acids, and which, when collected, proves to be a pure Sulphur, and the black colour induced on a paper, moistened with a solution of Sacch. Saturni, shew this very clearly. Some have incautiously rejected this from the catalogue of impregnations,

as

as it was not to be discovered in the residuum left on evaporation.

This, however, is not a sufficient reason, since, if we were to make an artificial impregnation of a Water of this kind, of the same strength with what we see it in springs, we should discern no traces of hepar sulphuris in the residuum left on evaporation, as that substance suffers a decomposition by solution in Water, and, moreover, the Sulphur itself would be dissipated by the degree of heat and continuance of it necessary for the evaporation.

The frequency of this impregnation argues strongly in favour of what has been before advanced, *viz.* that the fossile alkali is not always found, when native in the earth, in a perfectly mild state, as, when saturated with fixt air, it unites very imperfectly with, and enables water to dissolve but a small portion of Sulphur; whereas some springs are largely impregnated with hepar sulphuris.

'Tis almost needless to observe, that this circumstance corroborates the opinion before delivered, that the fossile oil is sometimes.

times found in springs in a saponaceous form.

On the whole, then, there is no doubt that this substance is a native impregnation of Mineral Waters.

HEPAR SULPH. *with* QUICK-LIME.

Hepar
Sulph.
with
Quick-
lime.

Calcareous earths, when deprived of their fixed air, unite with Sulphur in the same manner with alkalies, and possess the same property, though not in so great a degree, of rendering it miscible with Water

As calcareous earth is so generally dispersed through the subterraneous kingdom, it should seem likely that Sulphur might be frequently found in this state in Mineral Waters.

The same objection, however, occurs here, as in the last mentioned instance, *viz.* that calcareous earth is mostly found united with fixt air, in which state it will not unite with Sulphur.

This seems proved by the hardness and firm concretion of many marbles, which probably owe those qualities to the fixt air serving as a bond of union, as suggested by
the

the ingenious Mr. Macbride. This opinion is supported by their strong effervescence with acids. Other earthy bodies, of a more mixt nature, which are of a very firm texture, seem to owe their cohesion to the calcareous earth interposed between the other parts, which, being saturated with fixt air, keeps them together.

Thus we see many stones which fall into pieces on calcination, though but a small part of their composition consisted of calcareous earth.

Calcareous earth, likewise, though of a loose texture, is found united with fixt air. Thus chalk, whose concretion is very slight, effervesces strongly with acids, and has scarce any effect upon Sulphur. These reasons lead us to conclude against the probability of the existence of this impregnation. Yet I am inclined to think that the rule is not universal.

And here I must observe, that both alkalies and calcareous earths will unite with fixed air in different proportions, so as to form different degrees of causticity. Whether the fixt air in this case, when insufficient to saturate the whole, unites

itself to a part, rendering that perfectly mild, and leaving the rest caustic as before ; or whether it affects the whole, and is equally dispersed over it in less proportions, so as to form a kind of intermediate state between causticity and mildness, would be a curious question.

From analogy of acids and alkalies, the former would seem probable, but I think observation and fact favour the latter opinion*.

Thus much is certain, that several fossile bodies, when first dug, are in a state of attracting fixt air from the atmosphere. Thus chalk does not effervesce with acids so strongly when first got as when kept some time, and moreover by that acquires a greater degree of hardness, which can be only owing to its attracting fixt air. Many kinds of stone, likewise, when first dug, yield easily to the tool, so as to be worked with equal ease as wood ; but when used in building, or exposed to the air, acquire a great degree of hardness, so as scarce to bear any impression to be made on them.

* Mercury and Antimony seem to admit of an union with acids in a manner somewhat analogous to this.

I have observed, however, in the large pieces, that this acquired hardness decreases as you pierce into the body of the stone, and that in the middle of a large block there is still a part remaining soft and friable.

I have also remarked of all these stones, that they universally contain a considerable portion of calcareous earth, and the remainder mostly crystalline.

From what has been said we may reasonably conclude, that the calcareous earth in these stones is, in some degree, in the state of quick-lime, and that its hardening on exposure to the atmosphere was owing to its attracting fixt air from it, in the same manner as quick-lime does.

I shall give some experiments, tending to prove this point more fully, in the third part of this Work.

If, then, it be supposed, that calcareous earth, in its native state, sometimes possesses a degree of causticity, it will be easy to account for the impregnation of waters with this kind of *hepar sulphuris*. I have found by experience, that quick-lime, when

it had remained several weeks in a powdery form exposed to the air, and even effervesced in some degree with acids, still retained enough of its causticity to dissolve, by assistance of heat, a portion of Sulphur, and I even found this effect in some degree, tho' very slight, from a piece of fresh chalk.

I am, nevertheless, of opinion, that this impregnation is not to be expected to be found, except in the Thermal Waters, as I find that calcareous earth, in its most caustic state, as quick-lime, enables water to dissolve but a very small portion of Sulphur, unless assisted by heat. By that, however, its solvent powers are greatly increased. Probably it is owing to this circumstance, that this impregnation is not more frequent. With this restriction, nevertheless, I cannot but admit it into the catalogue of native impregnations of Mineral Waters.—

The last division of inflammable substances is

ARDENT SPIRIT.

Ardent
Spirit.

This, though of several degrees of strength, and variety of appearance, is ultimately

timately of one kind only, and never produced, except in consequence of the vinous fermentation, which there is not the least reason to think ever does, or can take place below the surface of the earth, as a communication with the air is necessary, and, moreover, it is generally thought no native fossile substance is capable of it.

This being premised, it is easy to conclude, that Ardent Spirit never can be found native in springs. Nevertheless, there are some circumstances occurring in nature, that seem at first sight to render this fact rather doubtful.

Herodotus, Polybius, Ovid, and Plutarch mention springs of a brisk vinous taste, sparkling appearance, and intoxicating qualities, and the last of these properties, and some degree of the two former, are remarkable in several springs that have fallen under modern observation. How this similarity of effects is to be accounted for, shall be considered when I come to treat of Aërial Bodies. At present I shall only say, that it is very probable that this effect is owing to the same cause in both cases, the substance
pro-

producing it being largely contained in many fossile substances, and likewise constantly present in the vinous fermentation. This causes that brisk taste, sparkling appearance, and inebriating qualities of some Mineral Waters, so much resembling the effects of fermented liquors ; but it does not appear that any of the springs that possess these qualities in the greatest degree, could, by any means, be brought to yield the smallest quantity of any ardent spirit on distillation ; a certain mark of their containing none. This substance, then, may be safely rejected from the catalogue.

The native impregnations of Mineral Waters with Inflammable Bodies are :

- | | | | |
|----------|---|-----------|--|
| Oil. | { | Simple. | 1. Oil fossile <i>per se</i> in a state of simple diffusion. |
| | | Compound. | 2. Oil in form of soap. |
| Sulphur. | { | Simple. | 3. Sulphur <i>per se</i> in a state of diffusion. |
| | | Compound. | 4. Hepar Sulph. with an alkali. |
| | | | 5. Hepar Sulphuris with quick-lime. |

C H A P. V.

Of MINERAL WATERS impregnated with Metallic Substances.

IT is a characteristic of this class of bodies, to admit of no chemical union with Water, whilst they retain their metallic form, and to be only miscible with it by means of some other body, which reduces them into a saline state*, in which, alone, they are capable of it. Solution, then, is the only method by which they can be thus united. Saline bodies, or at least bodies possessed of saline qualities, are probably the only solvents of metals we are acquainted with, and we

* Though it seems pretty clear, that all metallic bodies owe their solubility in water to their being reduced to a saline state, it is not meant that every combination of a metal with a saline body is soluble in water. Some of them seem to be decomposed by such addition, the water attracting the acid from the metal, and leaving only the calx. Thus the vitriolic and nitrous acids may be washed out by water from antimony; and the precipitation of silver from the nitrous acid, by means of the muriatic, by frequent washing becomes mild. Other saline bodies likewise only dissolve metals when in a concentrated state, and when diluted with water again let them fall.

may

may be well assured, that every metallic solution in Water contains a portion of some saline substance, combined with the metal. It may be objected, perhaps, that the several kinds of hepar sulphuris, and some aërial substances, which are not ranked in the class of saline bodies, possess the property of rendering some metallic substances miscible with water. But it should be considered, that pure sulphur has no such effect, but rather a contrary one; nor is any such produced until the sulphur is formed into a compound possessed of saline qualities, *viz.* sapidity to the taste, and solubility in water. Moreover, in the hepar sulphuris formed with an alkali, which is much the most active in this way, the alkali itself, in the state in which it properly admits of an union with sulphur, is a dissolvent of some metallic substances. It must be confessed, indeed, that it seems to form a kind of neutral body with the sulphur, and to acquire new properties in this way. With regard to aërial substances, it is more than probable that they act by means of some saline quality adhering to them.

The

The common air has been proved to contain a portion of saline substance, and in some of the hotter climates, is perceptibly saline to the taste.

This quality, likewise, is very distinguishable in the air, arising from effervescent mixtures when accumulated, and there is reason to think that a saline quality accompanies the air set loose by fermentation, and even that produced by putrefaction. The inflammable vapour, likewise, produced during the solution of metals in acids, partakes likewise of a saline nature.

Some oily substances, indeed, are found to act upon metals, but this is probably (in the vegetable oils,) in consequence of their containing some of the essential salt of the plant from which they were got. This is very evident in turpentine, where the essential salt often crystallizes by itself, and the same is true of the empyreumatic oils, as tar, from which a saline quality may be extracted by water.

Ex-

Expressed oils, both animal and vegetable, act upon metals more powerfully when rancid, which, perhaps, is owing to their generating a volatile alkali; and what seems to add weight to this is, that they then become miscible with water, which is probably caused by the intervention of that substance, as forming a kind of soap.

Essential, expressed, and even empyreumatic oils will unite with the calces made by fire of some metals very largely, and with others, when reduced into a saline state, by acids. But they have no such effect on them in their metallic state, except in consequence of their combination with some saline substance, nor is the compound thus formed in any case miscible with water.

I shall now proceed to treat of metallic substances separately, and examine them with respect to the means by which they may be rendered miscible with water. But as this is meant with a reference to the subject, *viz.* of determining the metallic impregnations of Mineral Waters, no substances can be considered here as
having

having that effect, except such as are native fossiles. Every metallic substance, therefore, which is not miscible with water by means of these, I shall not hesitate to deny its existence as a native impregnation of springs.—I shall take them in the order in which they are generally ranged, first, the pure metals, next the base metals, and lastly the semi-metals.

S E C T. I.

P U R E M E T A L S.

G O L D.

GOLD, in its metallic form, is not in the least affected by any of the fossil proper saline substances. The vitriolic acid may, indeed, be made, in certain circumstances, to dissolve it, but this only takes place when it has been previously dissolved, and precipitated again from its proper menstruum. Hepar sulphuris, indeed, will act upon it in its metallic state, and render it soluble in water; but to bring about this, it is necessary that the Gold should be fused along with it.

As

As the proper menstruum of Gold, *viz.* aqua regia, or a mixture of the nitrous and muriatic acids, is never found native, it can never be in a capacity of being rendered soluble by the first of these means; and as the degree of heat necessary to bring about the other does not occur in nature, there can be as little probability on that side. How far such a solution might accidentally happen by means of a volcano, or subterraneous fire, is not easy to determine. But if it should occur, it could not form an impregnation of a Mineral Water, as the vitriolic acid has this effect only in a concentrated state, and, when diluted with water, again deposits the metal.

What confirms the above theory is, that Gold has never been found native in a saline, or crystallized state, nor even, as most agree, in a mineralized one, but always in its metallic form. All these circumstances then concur to prove, very clearly, that it never can be an ingredient in any Mineral Water.

nions are, however, erroneous. The fixed Vitriolic Acid * acts, indeed, when dilute, very slowly upon copper in the cold, but will, nevertheless, completely dissolve it; and when the Acid is in its volatile state †, as it is supposed to be always when fossile and uncombined with any other body, its solvent power is very considerable, though the effect of this likewise is much increased by heat.

‡ The fossile alkali, probably only corrodes copper, and when much diluted,

* EXPERIMENT I.

Sixty drops of the vitriolic acid were added to two ounces of distilled water, in which were put a scruple of copper filings; they were suffered to stand together about twelve hours, and then the liquor was filtered off. It was nearly colourless, but had an evident taste of copper; and, on adding a few drops of sp. sal. ammon. cum calce viva, struck a fine blue colour. The filings appeared in part corroded.

† EXPERIMENT II.

Sixty drops of spiritus sulphuris per campanam, fresh made, were added, in like manner, to two ounces of distilled water, with a scruple of copper filings. After standing twelve hours, the liquor was filtered off. This struck a deeper blue on addition of a like quantity of sp. of sal. ammoniac, and the filings appeared more corroded than in the preceding Experiment.

‡ EXPERIMENT III.

Twenty grains of native fossile alkali, got by crystallization from the residuum of the waters of Carlsbad, in Bohemia, which contain it nearly pure, were added to two ounces of water, in which were put ten grains of copper filings; these

even this very slowly, if any, and if the air is excluded, not at all.

these were suffered to stand several days in an open vessel. The copper filings were not diminished in weight, or appeared to be at all corroded, but had acquired a brownish dusky colour; the liquor was then filtered, and appeared clear and colourless, without any taste of copper. I then added twenty drops of *sp. vitrioli*, which was more than sufficient to saturate the alkali, and redissolve the copper had any been contained in it. I then added a drachm of *sp. sal. ammon. cum calce viva*, but no blue colour was produced, a sure sign the water contained no copper. A few grains of the dry alkaline salt mixed with copper filings, in a few days evidently corroded them.

EXPERIMENT IV.

Two drachms of Glauber's salt were dissolved in two ounces of distilled water, to which was added a scruple of copper filings; the filings seemed little affected by standing in it twenty-four hours, and not more than some that were in common water, being only of a rather dusky colour. The liquor was then filtered, and was perfectly clear, had no taste of copper, and struck no blue on addition of ten drops of vitriolic acid, and one drachm of *sp. of sal ammoniac*.

N. B. Common salt and *sal catharticus amarus* were tried, in like manner, without effect.

I must observe, that what is here said, ought, by no means to encourage us to employ copper vessels in our culinary operations, where we have occasion to make use of saline substances of any kind, as all of these, when concentrated and assisted by heat, will corrode; and some of them, in these circumstances, even dissolve copper. In the former of these states even it would be easily separated from the sides of the vessel, and thus mixed with our food, and, in this state, if taken into the body, would be easily dissolved by the acid of the stomach, and exert the effects of verdigris.

Its solvent power seems increased by heat, but on cooling, it deposits what it had before dissolved. Glauber's salt, sal cathart. amarus, and common salt, likewise, when in a strong solution, corrode it, but the compound they form with it, does not dissolve in Water.

When diluted, they do not seem to act upon it, and probably in that case let go what they had before taken up.

The volatile alkali, indeed, acts very powerfully in dissolving Copper, but its existence as a native substance is too dubious to suffer us to admit it as an impregnation of springs. It certainly can never take place, except in extraordinary circumstances, such as the neighbourhood of volcanoes, &c.

* Fixt air, likewise, does not render Copper soluble in water, as it does iron. The

* EXPERIMENT V.

Ten grains of filings of copper were mixed with two ounces of distilled water in a vial, and by means of a crooked tube, numerous streams of fixible air from an effervescent mixture were driven on the surface of the liquor. The filings remained several days unaltered, and the liquor had not gained any taste of copper. It was then filtered, and
appeared

vitriolic acid, then, appears to be the only fossile saline substance, which, when diluted with water, is capable of holding Copper dissolved, and of consequence the only one with which this metal can be found united in a Mineral Water.

Experience confirms this opinion, as all the Mineral Waters hitherto discovered, that are impregnated with copper, contain it in the state of blue vitriol.

This impregnation does not occur so often as we might expect, from the frequency of Copper, as a fossil body, on account of the great quantities of iron every where dispersed through the bowels of the earth, which precipitates * it, and, moreover, the metal is seldom found native in a state capable of being acted upon, being either mineralized by sulphur, or, if in its metallic form, so firmly concreted with

appeared perfectly colourless, and transparent. To the filtered liquor were added three drops of sp. vitrioli, and afterwards a scruple of sp. sal. ammon. cum calce viva, but no blue colour appeared.

* *A priori*, we might expect to meet with this impregnation most frequent in the thermal springs, as the vitriolic acid, when heated, attracts copper stronger than even iron. Perhaps the degree of heat is seldom sufficient to have this effect.

some stony substances, as not to admit of the action of any menstruum upon it. It is, notwithstanding, sometimes found native in the earth, in a state of union with the vitriolic acid, and has been discovered present in springs, though not frequently in this form. It must, therefore, be accounted a native impregnation.

—— *Form* in which Copper is contained in Mineral Waters.

United with the vitriolic acid in form of
* *Blue Vitriol*.

I R O N.

Iron.

Impregnations of Mineral Waters with Iron occur more frequently than any others of the metallic kind. Several things concur to bring this about. The easy solubility

* I have since found, that alum acts upon copper in the way of solution, so that it is not improbable that this metal may be found present in those waters that contain this saline substance. Alum may be considered as acting upon metals in two ways, either in consequence of its superabundant acid, or by a decomposition of its parts, the acid being attracted by the metal stronger than by the earth of alum. But in either of these cases the metal would be united with the acid only, and would consequently appear in form of blue vitriol. See more on this head, in the next article concerning Iron.

of

of Iron in several saline fluids, and the superior strength of attraction which it has to them in comparison with all the other metallic substances, except Zinc, afford a very evident cause of this circumstance.

The vitriolic acid, in its fixed state, and when much diluted, acts very powerfully upon Iron; and there is no doubt that this combination is sometimes to be met with in Mineral Waters. This is evidently possible, from the proofs we have of green vitriol in its crystallized state being found a native fossil; and what confirms it is, that the same body has been got in a crystallized form, by the evaporation of the water of springs. This, however, can but seldom be the case, unless the proportion contained be very large, as, otherwise, the acid part would be dissipated during the evaporation, it being rendered, in some degree, volatile by being united with Iron.

But a more common impregnation of this kind is by means of the same acid in its volatile state, in which it acts more powerfully upon Iron than in the fixed.

This impregnation may be easily accounted for, from the vast quantities of iron pyrites so generally dispersed through the bowels of the earth, from which that acid (as has been before observed*) is always separated in its volatile state, and capable of acting immediately on the iron. In all probability, this impregnation would be more strong and frequent, were it not that the iron pyrites is scarce decomposed, unless the air has access, in some degree, which can scarce happen so often in nature as to account for the numbers of chalybeates that we see of this kind. Neumann has, however, mentioned, and I have myself seen, some kinds of pyritæ which suffer, though slowly, a degree of decomposition, even in close vessels, which may account for this appearance.

The fossile alkali acts upon Iron in the way of corrosion, but I cannot find that it† dissolves any.

* *Vide* Sect. I. on saline substances.

† Twenty grains of iron filings were added to two ounces of water in a vial, containing a drachm of fossile alkali. On standing four days exposed to the air, the filings appeared much corroded. Half an ounce was then filtered off, and appeared perfectly clear. To this was added, drop by drop, spirit
of

Some have been of opinion, that if to Iron, previously dissolved in the vitriolic acid, the alkali be added in greater proportion than will saturate the acid, that part of the * precipitated metal will be re-dissolved. Were the fact true, it might be easily supposed to happen in nature, by the interfering of the current of two springs, one containing an acid chalybeate, and the other an alkaline quality. But on experiment I cannot find that, in this case, the smallest particle of the Iron is re-dissolved; probably its action upon the metal, if any, is confined to it when highly concentrated. —I cannot, therefore, allow it to be accounted a native chalybeate impregnation.

The volatile alkali does not act upon iron in the way of solution in its metallic

of nitre, till the effervescence ceased; I then added some powdered galls, but not the least purple or black colour was produced.

* A scruple of green vitriol was dissolved in two ounces of water. To this was added two scruples of the fossil alkali, which was more than sufficient to saturate the acid. An ochrous precipitation ensued, which soon collected at the bottom of the vial. The liquor was then poured off, and filtered clear. To this was added, drop by drop, spirit of vitriol, until all effervescence ceased. I then added a little powdered galls, but no purple or red colour was perceived, nor was there any precipitation on adding the acid.

state,

state, nor does it attract acids so strongly. It never can, therefore, be the foundation of a chalybeate quality in Mineral Waters.

* Glauber's salt, the *salcatharticus amarus*, and common salt, corrode iron, but do not discover any effect in rendering it soluble in water.

Mineral Waters, impregnated with † *hepar sulphuris*, have the power of dis-

* Two drachms of Glauber's salt, *sal catharticus amarus*, and common salt, were dissolved, each of them in two ounces of water, in separate vials, and to each of them added twenty grains of steel filings. They were suffered to stand four days, and then from each was filtered half an ounce of the liquor, and to each half ounce was added two drops of spirit of vitriol; I then added galls, both in substance and solution, but no black or purple colour appeared, though I saturated the superabundant acid, after adding the galls with *lixiv. saponarium*. The above Experiment was tried with the assistance of heat, but without effect. It was also tried with selenites.

† Four ounces of Harrogate water were put into a bottle with a scruple of iron filings, and suffered to stand twenty-four hours, and then filtered. It struck a very deep black with galls. This succeeded in a great degree with some Harrogate water that had been exposed to the air near three weeks, by the bottle being left open, and suffered a large precipitation.

Left the aforesaid effect should be attributed to the fixt air in the water, though I should think that obviated by the circumstance mentioned of its long exposure to the air, I made the following experiment. I took two drachms of flowers of sulphur, and added to them one drachm of *lixivium saponarium*, and rubbed them well in a mortar together,

solving Iron, though but in moderate proportion. Probably this varies in proportion to the degree of impregnation. I am inclined to believe that there may be native chalybeates of this kind.

Hepar * sulphuris cum calce vivâ, likewise possesses some powers of this nature, though not so great as the hepar sulphuris with an alkali. As I believe the former of these to be a native impregnation, I must also admit a chalybeate one by means of it, into the number.

No simple earthy substance has, as far as I can find, the least effect in rendering Iron soluble in water.

The earthy saline body called † alum,

gether, and gradually added six ounces of distilled water. The whole was then filtered, and to it added twenty grains of steel filings; after standing six hours, I added a little solution of galls, and it immediately struck a purple colour.

* A drachm of flowers of sulphur was added to half an ounce of quick-lime and six ounces of water, and boiled together for some time, and then filtered. To the filtered liquor was added a scruple of iron filings. After standing four hours, it struck a light purple with solution of galls.

† A scruple of alum was dissolved in two ounces of water, and to it added some iron filings; after standing an hour, it struck a deep black with solution of galls. As there appeared little precipitation, in all probability the iron was here dissolved by the superabundant acid, which is always adhering to or united with alum, in the state we get it.

has,

has, indeed, this effect in a considerable degree upon Iron in its metallic state. But this cannot properly be accounted a native impregnation, as the Iron is not united with the alum, but with one of its constituent parts, viz. the vitriolic acid; the Iron attracting that acid stronger than the earth of alum does, and thereby decomposes it, so that it would appear to us in the form of green vitriol, and not as united with alum. It must, therefore, be referred to the first head of chalybeates.

Mephitic air has been of late discovered, by the ingenious Mr. Lane, to be a powerful menstruum for Iron, and from the frequency of its presence in chalybeate waters, he concludes it to be the medium by which they often become impregnated. He has besides suggested a probable method, by which we may account for its being present in springs, on supposition “that the water might be first charged
“with a pyritical matter (by which, I apprehend, he means a solution of Iron in the vitriolic acid, as it is extracted from pyrites,) “which might have the acid part
“neutralized by alkaline or calcareous
“sub-

“substances, and yet the Iron remain
“suspended by air generated during the
“saturation.”

I have made some experiments * myself which have agreed perfectly with those made by that ingenious Gentleman, and all tend to prove indisputably, that fixt air is itself sufficient to form a solution of Iron, without calling in the aid of any other menstruum. It was at first imagined by some, that the solution of Iron, in this manner, might be owing to a portion of acid adhering to the fixt air, since the latter substance is generally procured for the purposes of experiment, either by fermentation, or from effervescing bodies. In the first of these it has been often thought that an acid was always produced, and in the latter an acid substance is always necessary; part of which might be forcibly carried along with the stream of fixed air,

* Half an ounce of steel filings were added to four ounces of distilled water in a vial, and on the surface of this was driven several streams of air from a mixture of the fossil-alkali with the vitriolic acid. An ounce of this water, after filtration, gave a black colour with tincture of galls. I found the same effect, with some difference in the tinge, from magnesia and calcareous earth joined to the vitriolic acid.

rushing

rushing violently out from the effervescing mixture. But it appears to me, that these objections are void of foundation. As to the first, it has never been proved fully that any acid is necessarily generated in fermentation, much less that it was carried along with the exhaling vapour, the circumstances of pungency of taste, and change of vegetable blues to red, which have been chiefly urged in proof of it, being more probably attributed to the proper qualities of fixed air. As to the second, the alkaline particles might, with equal probability, be supposed to adhere to, and be carried over by the fixed air, during effervescence, as the acid ones; and moreover, the solution of Iron in Mineral Waters that contain an unneutralized alkali, prove very plainly, that this cannot be the case, as all the acids we are acquainted with attract alkalies stronger than they do metals.

Dr. Lewis has related an experiment* very much to the point in question, al-

* *Neumann's Chem.* p. 176. If equal quantities of green vitriol, and the mineral alkaline salt, or basis of sea salt, be dropped into a strong bottle filled with spring water, and the mouth instantly closed, so as to leave no vacuity in the vessel,

though he does not seem to have been sufficiently aware of the cause why the Iron was not immediately precipitated. But, in order to render this more clear, I made an * experiment, wherein it was necessary that the acid, had there been any, must necessarily have come into contact with an alkali, before it reached the Iron; and

vessel, the two salts will be slowly dissolved, and subsist quietly together as long as the vessel is kept closely stopped, there being no room for the extrication of the air, which all acids expel from alkalies, on uniting with them, and without the expulsion of which they cannot unite with them. As soon as the bottle is opened, the salts begin to act upon one another, and the liquor exhibits the same remarkable phenomena as the chalybeate waters do when brought up into the open air. It sparkles, or emits bubbles of air, tastes brisk and spirituous, as it is called, gives marks both of acidity and alkalescence, strikes with galls not the black that vitriol does by itself, but a fine purple. On standing for a little time it loses these qualities, the vitriol is destroyed, its iron falls to the bottom in form of ochre, its acid being absorbed by the alkali. The remaining liquor evaporated leaves only a little cathartic salt, and a part of the alkali unneutralized, together with a portion of marine salt, and different earths which the spring water contained before.

* To four ounces of water was added a drachm of lixivium tartari, (which I chose as the mildest alkali,) and the solution poured into a vial upon half an ounce of steel filings. The whole were then shaken until all the filings had subsided, and on the surface was driven a stream of air from an effervescent mixture, the liquor was then filtered, and gave a deep black with solution of galls. On addition of a few drops of any acid, a strong effervescence ensued with the alkali.

from

from this experiment I found the same effects, *viz.* the iron was dissolved, and the alkali not saturated. I found, likewise, that the air arising from * putrefying substances, and even the † human breath had this effect in a considerable degree.

It would be curious to examine the effects of fixed air, produced from various effervescing substances, as I cannot help suspecting that their effects would be very different in this way. Such an enquiry would exceed the limits of a Work of this kind, and farther than as relative to fossile substances, would be foreign to the subject.

* Eight ounces of ox gall were put into a quart bottle with a communicating tube with a bottle containing four ounces of distilled water, and half an ounce of iron filings, and set in an open place. After standing two days a small portion was filtered off, but it gave no colour with galls; but on the next day, when the fermentation in the gall became more evident, another portion struck a deep rosy red colour. I observed, that on the fifth and sixth days, when the gall became intolerably putrid, that though the vapour still corroded the iron filings, it had, in a great degree, lost its power of rendering them soluble in water. Does not this favour the opinion, that the vinous fermentation always precedes the putrefactive?

† By means of a blow pipe I conveyed my breath near six minutes in expiration through four ounces of water, in a vial, with half an ounce of steel filings; I then filtered the liquor, and on addition of tincture of galls, it struck a deep rosy red colour.

I have

I have not been able to discover which of them is the most powerful dissolvent, but shall just mention a difference in their effects.

I find the air produced from the vitriolic acid, and the fossil alkali, produces a blacker tinge with the same quantity of Iron, on addition of an equal quantity of tincture of galls, than that got from magnesia and calcareous earths, which gave rather a purple cast; whilst the breath, putrefaction, and fermentation, gave a rosy red colour. If the various colours which the different kinds of air got by effervescence of fossil substances with the vitriolic acid give on addition of galls to chalybeate solutions, formed by their means, were accurately noted, it would throw great light on our examination of Mineral Waters.

I cannot, nevertheless, agree in opinion with that Gentleman, that fixt air is, in general, requisite to the impregnation of Chalybeate Waters, or that all the fugitive impregnations of this kind are formed by these means. I myself have seen a strong chalybeate impregnation, as volatile as any native one, artificially given to distilled

L

water,

water, merely by infusing in it a sandy substance found at the bottom of a spring, and which was brought up by the stream ; and I have been well assured that this circumstance is not uncommon.

As fixt air is so powerful a solvent for Iron, it seemed likely that the vapour arising from a solution of metals* in acids (particularly of Iron in the vitriolic acid) which resembles, in some measure, fixed air in the manner of its production, and which we see so frequently present in the bowels of the earth in form of an inflammable exhalation, might have some effect in promoting the solubility of metals in water, but I cannot discern any such effects, on examination.

On the whole, then, it seems probable, that the native chalybeate impregnations of Mineral Waters may be of five kinds.

* Two ounces of oil of vitriol, diluted with six ounces of water, were poured on two ounces of iron filings, in a pint bottle, communicating, by a bent tube, with another containing four ounces of water, and half an ounce of iron filings. The vapour passed over in great quantity near twenty minutes, on the surface of the water, containing the iron filings, which was then filtered, and to it added a few drops of tincture of galls, but no black or purple colour was produced.

Iron com- bined with	Saline Bodies.	{ Acids.	{ 1. Fixt Vitrio- lic Acid.
			{ 2. Vol. Vitro- Acid.
	Inflam- mables.	{ Sulphur in com- position.	{ 3. Hepar Sul- phuris with an Alkali.
			{ 4. Hepar Sul- phuris with Quicklime.
	Aërial Bodies.		{ 5. Fixt air from divers sub- stances.

L E A D.

Lead is very rarely, if ever, found native Lead.
in the earth in its metallic form, being
almost constantly united with Sulphur, in
form of an ore. In this state it is not
acted on by any menstrea whatever, nor
indeed do any of the fossil kind, except the
vitriolic acid, affect it in its metallic state;
and even this has no effect in that way,
unless assisted by a boiling heat. It may,
therefore, be safely excluded from the list
of native impregnations of Mineral Waters.

T I N.

This metal is very seldom found native Tin.
in the earth in a state capable of being
L 2 acted

acted upon by acids. The vitriolic acid does not dissolve it, except when concentrated and of a boiling heat, and when again diluted the Tin is precipitated. Hepar sulphuris likewise dissolves Tin, and renders it soluble in water, but not unless added to the metal whilst in fusion. No other fossil saline body has the least effect upon it. It never, therefore, can enter into the composition of any Mineral Water.

S E M I - M E T A L S.

M E R C U R Y.

Mercury.

Mercury is sometimes, though rarely, found native in the earth in a fluid form. In this state it is soluble in the vitriolic acid, but not unless concentrated and assisted by heat, which are two circumstances not to be expected to occur below the earth. Hepar sulphuris, likewise, does not affect it, unless accompanied with heat. No other of the fossil menstrua affect in the least. There are some accounts of Mercury flowing out with the current of springs in its native form, but I know not if they are to be relied on.
But

But even in this way, granting the fact to be truly related, it did not form an impregnation of the spring. Its general appearance is in form of Cinnabar united with Sulphur, in which state it is totally insoluble in all menstrua whatever. It must, therefore, be excluded.

B I S M U T H.

This metallic substance is not dissolved by any of the fossil menstrua, and cannot, for that reason, ever impregnate a Mineral Water. Bismuth.

Z I N C.

This semi-metal is sometimes met with in a crystalline form in the earth, united with the vitriolic acid. Nor is this to be wondered at, since it precipitates all metals, even Iron, though of this last circumstance, when that metal is united with the vitriolic acid, Neumann seems to doubt. In this state it is soluble in water, and may, doubtless, be an ingredient in the composition of Mineral Waters. A great Chemist is of opinion, that it occurs in this manner. Zinc.

ner oftener than is imagined, and that its not having been noticed by the Chemists was not so much owing to its absence, as to their not having had it in view. Neumann, indeed, mentions it as contained in some Mineral Waters, but brings no experiment in proof of it. None of the other fossil menstrua affect it in the least; nay hepar sulphuris, even in fusion, does not act upon Zinc.

Form in which ZINC is contained in Mineral Waters. United with the Vitriolic Acid, in form of WHITE VITRIOL.

ANTIMONY.

Antimo-
ny.

This metallic substance is never found native in its reguline or pure state, being always combined with a portion of sulphur, which defends it from the effect of acids. Alkaline salts, indeed, absorb its sulphur, and form therewith a compound capable of dissolving it. This, however, cannot happen, unless a greater degree of heat was employed than water is capable of receiving. It is doubtful if the vitriolic acid acts at all on the crude Mineral, but
this

this we may be certain of, that it never can, by means of that solvent, impregnate a Mineral Water, as the vitriolic acid does not dissolve it unless when concentrated, and when again diluted lets it fall entirely. No other fossil saline substances affect it in the least; it may therefore be safely excluded.

A R S E N I C.

This, though generally arranged under the head of the Semi-metals, seems to incline rather to the saline kind, as it dissolves entirely in water. On this account, and as it is so frequently present in the earth, we might expect to see it sometimes present in Mineral Waters. Arsenic.

But on more accurate examination, it appears to be soluble in water only when deprived of its phlogiston, and when that is restored, it is insoluble. Happily, when native, it is always found combined with Sulphur, in which state it is not acted on by any menstrua; and we find by experiment, moreover, that if a small quantity thus combined should be accidentally received into the human body, it could produce no bad consequences.

Arsenic has been said to be found in the Waters of Chevron, or Bru; but on examination, this appeared to be only a report founded on interested motives, in order to raise the credit of some neighbouring Mineral Waters at their expence.

It may then be safely excluded from the catalogue of native Impregnations.

REGULUS of COBALT.

Regulus
of Cobalt.

This metallic body is little known; when native it is always found in a state of union with sulphur and arsenic, which made it long imagined to be an ore of the latter of these. It is now found, however, to be a Semi-metal *sui generis*. In the state it is found native, it is not acted on by acids, or any fossil menstrua, and of consequence can never impregnate a spring.

NICKEL.

Nickel.

This body is never found native free from Sulphur, it attracting that substance strongest of any metallic body known. When in this state, it, like other metals, does not yield to any menstrua, and of consequence can never be found in Mineral Waters.

All

All the metallic Impregnations of Mineral Waters may be reduced to the following.

	Copper.	1. Vitriolic Acid in form of Blue Vitriol.— Q. Is Copper ever found combined with the Vol. Vitriolic Acid? I think not, as it is always easily crystallized from the Waters that contain it.
Base Metals.	in a state of solution by	2. Fixt Vitriolic Acid, in form of Green Vitriol. 3. Volatile Vitriolic Acid, as in many Chalybeates. 4. Hepar Sulphuris, with an Alkali. 5. Hepar Sulphuris, with Quick-lime. 6. Fixt Air from various Substances.—Q. If these form different kinds of Chalybeates?
		Iron.
Semi-Metals.	Zinc.	7. Vitriolic Acid, in form of White Vitriol.— Q. If ever united with the Volatile Vitriolic Acid? I think not, for the reason given above concerning Copper.

C H A P. VI.

EARTHY IMPREGNATIONS *of*
MINERAL WATERS.

IN speaking of these bodies, I shall, in the first place, treat of the various kinds of earths in their simple state, and then as combined with such fossil substances as render them soluble in water*.

Insolubility in a watery menstruum has been esteemed a general characteristic mark of earthy bodies in their simple state. But I cannot think this well founded, since one kind of them, in the most simple state in which we can procure it, is largely soluble, and in fact seems to owe its insolubility only to its being, in some degree, in a compound state, and to its union with a body no ways essential to

* These last, as bearing the characteristic marks of salts, might be referred to the head of Saline Impregnations, but I rather chose to confine that term to the simple Saline Substances, and those compound salts which are properly called neutral, and are formed by the union of the simple Saline Substances, and to consider the metallic and earthy salts under separate heads.

it, as an earthy substance. Moreover, if the theory of an ingenious Gentleman be well founded, it is likewise soluble when the same substance is united with it in over proportion.

The first of these facts is well known to be true; and how far the latter opinion is so, I shall soon proceed to enquire.

S E C T. I.

SIMPLE EARTHY SUBSTANCES.

Simple earthy substances are generally thought to be of four kinds.

- | | |
|------------------|--------------------|
| I. Absorbent. | III. Argillaceous. |
| II. Crystalline. | IV. Talcy. |

ABSORBENT EARTHS.

Absorbent Earths are of two kinds,

1. Calcareous.
2. Magnesia.

CALCAREOUS EARTH.

The first of these, in the state we generally see, it is united with such a portion of fixed air, as renders it totally insoluble
in

Calcareous Earth

in water. Nevertheless, when deprived of this substance, either by calcination, (which is the most common method,) or by other means, it becomes entirely soluble in that menstruum; though, indeed, but in small proportion to the bulk of water necessary for its solution.

It has been generally imagined, that calcareous earths, in the state they are found when native fossil substances, are united with such a quantity of fixed air, as prevents their solution in water; and this opinion appears to be, in general, true. I am, nevertheless, well satisfied, that there are several exceptions, and that all those stones, of which a considerable part is * soluble in acids, and which are, when first dug from the quarry, very soft, and afterwards harden in the air, owe the two last qualities to the Calcareous Earth which they always largely contain, and which seems to be the bond of union of the other parts, being, in some degree, in a

* The solubility of a considerable part of these stones in acids, is a necessary circumstance to be taken in, as some of the steatite are soft when first dug, and afterwards harden in the air. These, however, being of the argillaceous kind, do not dissolve in acids.

caustic state, or not united with its full portion of fixed air, which the learned Mr. Macbride has, with great probability, imagined to be the uniting principle of the Calcareous Earth itself. The hardening of these stones on exposure to the air, is most probably owing to their attracting fixt air from the atmosphere.

I find, by experiments * made on several stones of this kind, that, when fresh dug, they impart an earthy impregnation to water, possessing, in a considerable degree, a taste similar to that of a solution of lime, only wanting much of the empyreumatic flavour, from which, nevertheless, it was not entirely free.

It appeared, moreover, capable of acting, in the way of solution, upon sulphur very powerfully, as lime does; and the hepar sulphuris made by means of it, exhibited the same appearances with an artificial solution of sulphur in water, made with quick-lime.

* It was thought unnecessary to set down the experiments at length here, as it will be necessary to mention them again, when we come to treat of the Impregnations of the Bath Waters.

I am,

I am, therefore, well satisfied, that Calcareous Earths may be thus found contained in Mineral Waters.

It has been hitherto generally imagined, that Calcareous Earths were soluble in water, only in consequence of their being in a caustic state, or deprived of their fixed air. But in opposition to this opinion, the ingenious Mr. Cavendish, to whom the literary world are greatly indebted for his curious researches into this branch of knowledge, has brought several very plausible arguments, to prove that Calcareous Earth may be rendered soluble in water, by being united with an over proportion of fixed air, as well as by being deprived of it altogether.

This opinion, though quite contrary to that hitherto received, seemed farther strengthened by a subsequent discovery, that fixible Air possessed a power of rendering other substances soluble in water, as it is now found to be a powerful menstruum for iron. Notwithstanding this great authority, I hope I may be pardoned if I presume to dissent, as I acknowledge that Gentleman's Experiments, in order to
prove

prove this, though highly worthy attention, did not appear clearly to me to lead to that conclusion. I am, nevertheless, well satisfied, that many powerful arguments may be urged in favour of that hypothesis; and though the experiments I have myself made did not (as far as I can judge) favour that opinion, I do not so far flatter myself, as to think they amount to prove the contrary of what Mr. Cavendish has advanced, but would have them understood rather as a plea in behalf of my doubt of an opinion supported by so great authority. The limits of this work will not admit so full a discussion as the subject would require, particularly that of considering, in detail, each experiment made by that Gentleman, and the conclusions thence deduced, in order to prove this point. I shall therefore only put down some experiments of my own, relative to the subject, and subjoin a few observations.

E X P E R I M E N T I.

Ten ounces by weight of lime water, made by pouring distilled water on three several portions of fresh quick-lime, were put into a glass decanter, and exposed to
the

the fumes of an effervescent mixture, (composed of chalk and the vitriolic acid,) conveyed on the surface of the water, by means of a bended tube, resembling that used in Mr. M'Bride's Experiments, and having the junctures secured with a piece of bladder, tied with a waxed thread. The vitriolic acid was poured upon the chalk, by means of a funnel inserted into a small opening made in the side of the bottle, which was immediately afterwards closed, so that very little of the fixed air escaped. In a few moments a plentiful precipitation of a flocculous matter appeared, which continued near half an hour, and then gradually ceased, and the liquor above became quite clear. Several fresh streams of air, generated by adding fresh quantities of vitriolic acid to the chalk, were then conveyed on its surface, but no new precipitation could be perceived. On standing closed up, the sediment appeared to diminish in bulk, but on closer inspection it seemed evidently owing only to the precipitated particles becoming more condensed together. Not the least appearance of redissolution could be perceived, although the bottle was shaken, and

and the sediment stirred up, and repeated streams of air driven on the surface of the liquor.

N. B. This experiment was tried with the air arising from the effervescence of spirit of nitre, of spirit of salt, and of vinegar, with chalk, and of spirit of vitriol, and of spirit of nitre with lixivium tartari; and the same effect was found to be produced by them all.

EXPERIMENT II.

After the precipitation mentioned in the last experiment had fully subsided, and the fluid above clear, as much of the liquor as could safely, without disturbing the sediment, was decanted off, and the remainder evaporated with a gentle heat, so as to leave the residuum perfectly dry. It appeared to be a white insipid powder, weighing exactly twelve grains. The liquor poured off was about eight ounces, had lost all the astringent taste of lime water, but retained somewhat of the empyreumatic flavour.

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Ex-

EXPERIMENT III.

To six grains of the above mentioned residuum was added a drachm of spir. nitri, diluted with half an ounce of water. A violent effervescence ensued, and in a short time the precipitate was entirely dissolved.

EXPERIMENT IV.

To an ounce of the clear liquor decanted from the residuum, mentioned in Experiment II. was added two drops of spirit of nitre. Not the least effervescence ensued.

EXPERIMENT V.

To an ounce of the same liquor was added two drops of the fresh expressed juice of the cyanus. No more change of colour was observed than from diluting it with the same quantity of distilled water.

EXPERIMENT VI.

The remainder of the liquor, being about six ounces, was set in an open glass vessel several days in a chamber window, exposed

to the sun and air. It lost, by degrees, all its empyreumatic taste, but not the least precipitation could be discovered. It was then entirely evaporated by a gentle heat, but did not leave more than about a grain of residuum, which was of an ash colour, and not entirely soluble in acids.

EXPERIMENT VII.

Ten ounces (by weight) of the same lime-water with that mentioned in Experiment I. were evaporated to dryness in a china basin over a lamp. The residuum weighed exactly fifteen grains, and resembled in all respects that precipitated by fixed air.

EXPERIMENT VIII.

Sixty grains of chalk, which had been previously levigated and washed in several waters, was added to ten ounces of distilled water, in a large clear vial. I then inserted into the neck of the vial a tin tube, the end of which descended two inches below the surface of the liquor, and the other end was fixed into a bottle containing an effervescent mixture of lixiv.

M 2

tartari

tartari and spirit of nitre*. The junctures were previously secured by bladder, and the bottle, containing the chalk, was shaken gently, so that the powder was dispersed through the liquor. Not the least sign of any solution could be perceived, nor did the chalk appear, on its subsidence, to be diminished in quantity, though repeated streams of air were introduced.

EXPERIMENT IX.

I decanted off clear about eight ounces of the water from the chalk mentioned in the last Experiment, as soon as it had perfectly subsided, and evaporated the remainder. The chalk appeared unaltered in all respects, being quite insipid, totally soluble in, and effervescing with, the nitrous acid, and only diminished in weight two grains. The decanted liquor had acquired a brisk vinous taste.

EXPERIMENT X.

To one ounce of the liquor decanted off in the last Experiment, I added four drops

* The same effervescing mixtures were tried with this as with lime-water.

of spirit of nitre. Not the least effervescence appeared.

EXPERIMENT XI.

To about an ounce of the same liquor I added two drops of the fresh expressed juice of the cyanus, but no more change of colour could be perceived than what happened from the dilution.

EXPERIMENT XII.

The remainder of the liquor, now reduced to five ounces, was slowly evaporated, but left scarce any residuum. What there was, was of a grey colour, and was probably only some accidental dust that it had attracted.

By the first of these Experiments it appeared, that a certain portion of fixed air precipitated the earth from the lime-water, but on adding a fresh portion none could be discovered to be re-dissolved.

I repeated this Experiment with several acids, and with alkaline salts as well as earths, not only to ascertain the similitude of effect of the air produced by each, but also to take off the objection if the vitriolic

M 3

acid

acid only had been used, that part of it, during effervescence, might have been forced over into the lime-water, and, by uniting with the earth, formed a selenites, which might have been suspected, on account of its little solubility in water, to have given occasion to the precipitation. This, however, is fully obviated by the use of the nitrous and muriatic acids, as the compounds these earths form with the nitrous and muriatic acids are extremely soluble in water.

On comparing the second, sixth, and seventh of these Experiments, it seems pretty clear that the whole of the earth was precipitated from the water. Somewhat of the distinguishing empyreumatic flavour, indeed, remained, but this, I am well satisfied, was owing to some oily substance, from which scarce any water can be got entirely free, and not necessarily dependent on the earthy impregnation.

Some degree of a taste of this kind often attends water fresh distilled, which water, nevertheless, when evaporated, leaves no perceptible residuum.

Ex-

Experiment III. farther proves that the precipitation was an absorbent earth, since selenites does not dissolve in spirit of nitre.

Experiment IV. in my opinion, proves that none of the calcareous earth was dissolved in the water by means of being united with an over proportion of fixed air. Had this been the case, an effervescence ought to have appeared, which, indeed, being no more than the evolution of the air bubbles, occasioned by the stronger attraction of the acid than of the fixed air to the earth, ought in this case to be more remarkable, as the earth was united with a superabundant portion of air.

On this principle, all those waters that leave a calcareous earth on evaporation ought to effervesce strongly with acids, which I find by experience not to be the case. Those waters which should seem most favourable to such an experiment would be those of the petrifying kind, which deposit spontaneously their calcareous earth. But these I have not had an opportunity of examining.

Experiment V. farther proves, that the water had lost one of the great distinguishing marks of its containing a calcareous earth in solution.

Experiment VIII. is made with a calcareous earth saturated with fixed air, and such as the water might be expected to meet with in its passage under ground.

In this Experiment the air was made to pass through the body of the water, and to be applied more immediately to the earth, than in the Experiment with lime-water, where it only came on the surface; nevertheless, no more signs of solution appeared than in the former Experiment with lime-water analogous to it.

The remainder of the Experiments will be easily understood, by comparing them with the former experiments made, corresponding to them upon lime water.

I have thus laid down the reasons which incline me to doubt in a great measure if Mr. Cavendish's ingenious hypothesis be well founded. Whether they are just or not, I leave others to determine, but cannot help myself thinking them of sufficient weight to deserve attention, and induce farther

farther enquiry into the foundation of the opinion.

I beg leave farther to observe, that a calcareous earth being found in the residuum left by waters on evaporation, is by no means a certain proof that it existed previously in them in an unneutralized state, as some have imagined. Dr. Percival has proved beyond a doubt, that all waters containing selenites, deposit, on boiling, a calcareous sediment, owing to the decomposition of the selenitic salt, by heat applied to it in solution, the acid flying off, and leaving its earthy basis behind; and he found, likewise, that in consequence of this separation, the water lost, in a great degree, its hard qualities, and acquired the power of uniting, in some measure, with soap. The want of this last quality could never be attributed to the presence of the calcareous earth in an unneutralized state. Moreover, the waters thus examined, gave not the least signs of containing fixible air, or deposited the least sediment on standing. It is likewise found, that by long boiling the alkaline basis of some neutral salts is convertible into an earthy substance. Thus we see the common table salt we use almost
always

always containing either a portion of an earthy salt, or having a portion of unneutralized earth adhering to it, and generally both. This is well known to be owing to the change induced on the alkali by great heat and long boiling, as the water, or brine, from which it is got, when slowly evaporated, is not found to contain any unneutralized earth, or earthy salt. On this principle depends the superiority of the foreign salts, that of the Isle of May in particular, to the English.

Such are the grounds for my doubts of the foundation of Mr. Cavendish's ingenious hypothesis. I must, however, repeat, that all I mean to inculcate is, the necessity of a farther enquiry. I once intended to have considered it more largely in this place, but found the subject so copious, as not to admit of insertion at length. I therefore determined to put down no more than what my own experience had led me to imagine, and I hope that what has been said on this subject, though far from amounting to proof, will, nevertheless, authorize me in declaring my doubt of the possibility of this impregnation.

This

Magnesia

This earth is never found native in its separate state, in Mineral Waters being not soluble in water. Magnesia, though it unites easily with fixed air, does not become caustic by being deprived of fixt air, like calcareous earth; in compound form it frequently occurs, as will be soon taken notice of; but in its simple state is incapable of any permanent union with water. It may then be safely rejected from the catalogue.

Crystalline Earths

These in their native state are not acted upon by any known menstruum. When fused with an alkaline salt in large proportion, as of twice, thrice, or even equal weights, they become soluble in water. This process, however, is one of those which we could not *à priori* expect Nature to imitate. But this is another case, wherein we must not too rashly attempt to set bounds to her operations, as there is good reason to believe that these bodies have been found in some Mineral Waters in a state of solution. I am nevertheless inclined to believe, that this was not brought about by the means abovementioned, as the crystalline earth, by that process,

process, appears to be changed into an absorbent one, and the crystalline earths, which have been discovered in Mineral Waters by Mr. Pott and Magraaf, appeared in their original form. But all the impregnations of this kind hitherto discovered are so slight as not to come under the definition of Mineral Waters, and of course not comprehended in the present intention.

Argillaceous Earths

With respect to these there is great doubt whether or no they are primitive earths; some experiments lead us to think them to be a compound, consisting of a crystalline and calcareous earth. But as this point is not fully proved, and as the argillaceous earth, even granting it to be a compound, is such a one as we cannot by any artificial combination imitate, and as it differs considerably from the other simple earths, it may be considered as distinct.

Pure argillaceous earth is soluble in the vitriolic acid, but the solution does not take place except assisted by heat and long digestion, and the acid be in a moderately concentrated state. Notwithstanding the little reason there is to expect the concurrence

currence of these two circumstances in the bowels of the earth, some Writers have asserted the existence of this earth, as well as the last mentioned, in a state of solution, in Mineral Waters. But as the quantity mentioned to be dissolved ~~in three ounces~~, by their own account, is so small as not to cause any visible difference, either in appearance or effects, from common water, it may very properly be disregarded.

Talky earths
These are not the least affected by any known menstruum, nor is there the least authority that I know of for their being found in any Mineral Water. They may then be very properly rejected from the catalogue.

S E C T. II.

COMPOUND EARTHY SUBSTANCES.

The only proper compound state in which earths are found native, and capable of being dissolved in water, is in a state of union with the vitriolic acid.

The first of these I shall treat of is the union of the calcareous earth with that acid.

SELE-

SELENITES.

Selenites.

This is by much the most general impregnation that has been discovered, and indeed is so much so, as to be almost, in some degree of it, universal. To this impregnation is owing that quality of waters which is commonly called hardness, which is given to those waters which have the power of decomposing, or, as generally termed, breaking soap. Other substances, however, as the vitriolic acid separate, the sal cathartic. amar. alum, iron dissolved by an acid, and perhaps fixed air in large quantity, impart the same property.

This impregnation, although so frequent, is, notwithstanding, never found but in very small quantity, in proportion to the bulk of water, owing to the very sparing solubility of this substance.

SPURIOUS GLAUBER'S SALT.

Spurious
Glauber's
Salt.

This is very often a native substance, and, on account of its easy and plentiful solubility, it is frequently found in Mineral Waters. On account of the last of these qualities, we meet with more degrees of this than of the foregoing impregnation.

It

It has been before observed, that this saline body has often been mistaken for the true Glauber's salt, from which nevertheless it is essentially different, as having an absorbent earth, called Magnesia, for its basis, whereas the other has the fossil alkali.

A L U M.

The last earthy substance, that comes under consideration, is Alum; concerning this there are great disputes among the learned, whether or no it is ever found impregnating a Mineral Water. It has been urged, on the one hand, that Alum is no native fossil production, that the substances from whence it is got, betray no marks of containing it, when newly dug, until they have suffered a decomposition by exposure to the atmosphere. Neumann * asserts, that Nature affords no perfect alum; and though both he and Hoffman † suspected it to be present in some Mineral Waters,

Alum.

* Vide Neumann's *Chemistry*, p. 185.

† Quamvis igitur fateamur nos nunquam in aquis foteriis alumen deprehendisse, non tamen inficias utimus quod iis in locis ubi uber aluminis in subterraneis tractibus est proventus, illudque copiose effoditur fontes eodem imbuti scaturiant. *Hoffmanni Opera*, tom. quintus, p. 140.

they

they could never find any that gave any signs of it on crystallization. That the austere taste, and precipitation with alkalines, are common to the selenites, or hard waters, as well as the aluminous. That it is very dubious, except in accidental circumstances, if the vitriolic acid is ever found a native fossil in its separate state, and at liberty to unite with the aluminous earth, and that if such an accidental combination should take place, on its solution in water, it must soon be decomposed, the phlogiston, alkaline salts, calcareous earth, and magnesia being more strongly attracted by the vitriolic acid than the earth of alum.

To these arguments it has been replied, That there is undoubted evidence, that alum has been found in its crystallized state in the neighbourhood of green vitriol; that some earths and flates have a manifest aluminous taste when newly dug, and from which alum is directly elixated, without any previous exposure to the atmosphere. That if any air be necessary to its production, that is sufficient which is contained in the interstices between the laminæ
of

of the slate, from whence it is got, which is of that texture as the aluminous matter may be often there plainly distinguished. That the cause why Neumann and Hoffman could not procure it by simple evaporation, was, that there is almost constantly united with alum an earthy substance, and some metallic matters, which require to be previously precipitated before the crystallization will take place, as the liquor of itself will not shoot, but either continue fluid, or, if farther evaporated, would yield only an unctuous mass. That, with this intent, the Alum-makers always add a quantity of alkaline salt, or urine, or sometimes both, in order to precipitate these which obstruct the crystallization. That the objection concerning the vitriolic acid is of no consequence, as some kinds of pyrites, from which substance it is frequently got, suffer a decomposition by moisture only, which would be more likely to happen from the additional attraction of the aluminous earth, which is frequently found, as in the aluminous pyrites, in contact with it.

That as to the decomposition of alum by alkaline, earthy, and metallic matters,

N

it

it is very probable that this very often happens, as aluminous waters are not near so common as we might expect, from the frequency of the component parts of alum in the bowels of the earth; yet, nevertheless, either from these substances not interfering with the current of the stream before it rises to the surface, or from the quick passage of the water over them not allowing time to dissolve sufficient of the earth, or metal, to precipitate all the earth of alum; it is very possible to suppose, that impregnations of this kind may sometimes occur. In the same manner we see the fossil alkali, whose attraction to the vitriolic acid is so strong as to decompose every other saline compound in which it is contained, many of which occur so frequently in the earth, yet is sometimes found in its separate state in springs. If we allow the presence of the vitriolic acid separate in Mineral Waters, it is easy to account for an aluminous impregnation, since Dr. Lewis has proved by experiment, that the argillaceous earth is capable of being converted by the vitriolic acid into earth of alum. Nothing more, then, is necessary, than to suppose a spring thus impregnated
running

running through a bed of clay. This is confirmed by an observation, that aluminous waters are frequently found in the neighbourhood of volcanoes, where the vitriolic acid is subject to be often disengaged by fire from the Pyrites. It seems, moreover, probable, that a perfect alum is generated in clays by the action of the fire. Dr. Percival found, that bricks imparted an aluminous impregnation to water, and on that account very properly cautions against lining the sides of wells with brick; and it is not improbable that the astringent taste in some of our spring waters is owing to this cause.

On the whole, then, from the review of the arguments on both sides, it seems to me very clear, that alum is a possible impregnation of Mineral Waters, which opinion is farther confirmed by several actual proofs of its existence there. It must therefore be admitted into the catalogue of native impregnations.

C H A P. VII.

AERIAL IMPREGNATIONS *of*
MINERAL WATERS.

WE now come to the last, though not the least important impregnation of Mineral Waters, *viz.* with Aërial Bodies.—These are generally thought to be of three kinds :

1. Common or Atmospheric Air.
2. Fixible or Mephitic Air.
3. Inflammable Air.

COMMON AIR.

Common
Air.

This is possibly the only kind of air that does not admit of being subdivided into several species. It may, indeed, be united with several bodies, but, when collected separate, appears to be of one kind only. Whether this is ever found native in springs, remains to be considered. The presence of an aërial fluid in common water, is frequently obvious to our senses, and at all times discoverable, by placing it under the exhausted receiver, when
numerous

numerous bubbles will immediately rise through the body of it. Whether this ærial fluid be the same with that of the atmosphere, affords room for a curious question.

Common Air is certainly miscible with water, as we see in the machine for raising a blast of wind by means of water, which depends on this principle. But in this way the air seems to be only entangled in the water, as it quickly escapes, though, in all probability, a portion is still retained sufficient to saturate the water, and only so much separated as is above that proportion. But what is the strongest argument is, that lime water is not precipitated by addition of common water, and when placed under a receiver * emits air bubbles, which cannot be supposed to be of the mephitic kind, as that having so strong an attraction to calcareous earth in a caustic state, would unite with it, and precipitate it from the water.

Common Air seems frequently to be united in over proportion with the common

* I never tried this latter experiment, but had it, I believe, from good authority.

water we drink, from its being entangled in its fall from the tube, from whence it flows. This is frequently the case in our pump waters, and to this is owing the numerous air bubbles, which we so frequently see at the bottom of glass decanters, filled with water from a pipe. To the same cause may be imputed the sparkling appearance of some Mineral Waters, which is attributed, though sometimes with reason, often erroneously, to fixible air. I have seen some Mineral Waters which contained the latter substance in great quantity, and yet exhibited very little appearance of this kind to the eye, when taken up by immersing a vessel slowly into the spring, but when poured out from a bottle shewed great signs of it. For this reason, I apprehend, that where the effects of the waters depend on this quality, that the manner of taking them up from the spring, as at Tunbridge and Buxton, would be preferable to a pump. The cause of the separation of the fixible air from the water is most probably owing to its being attracted by the common Air. It is then very obvious, that by falling from the pipe of the pump, a
much

much larger surface of the water must be exposed to the common Air than in the other method, and which, by its being thus mechanically united with the water in its fall, must greatly increase the opportunity of its uniting with the fixible air, and of consequence promote the dissipation of the latter.

It may be perhaps thought, that an impregnation of this kind can scarce come within our definition of Mineral Waters. But there is no small reason to think, that the presence even of common air in water is by no means an indifferent circumstance with regard to its action on the human body; since it is found by experience, that water which has been frozen (which seems to separate all the air of every kind,) is not fit for the purposes of diet, yet the water seems to have suffered no change, except in this respect; and on that account, the ingenious Dr. Percival has, with great probability, referred the ill consequences which it appears to have on health to this cause.

It may be perhaps owing to this, among other circumstances, that spring water be-

comes fit for several purposes in the mechanic arts, as the solution of several substances, and even in diet, by being exposed to the air, which it would not serve at its first rise.

If this theory be just, it should caution those who are accustomed to drink boiled water, to expose it a sufficient time to the atmosphere, to recover the air which had been separated by the boiling.

It is possible that the fixible air in many Mineral Waters supplies the want of common air, to render it proper to be taken into the human body.

As to common air being a native impregnation of Mineral Waters, I cannot think it can strictly be esteemed so, although I make no doubt, that it is contained in many of them, as offered to us, either from its being entangled with them, in the way before mentioned, or from their being exposed in a large surface, at their first rise, a sufficient time for them to acquire of it a certain proportion.

Although then, in strictness of speech, it cannot be admitted, yet, as it is almost
always

always present in them, in the state in which we use them medicinally, and as it is not introduced there by any artificial means, it may in this light be accounted a native impregnation.

FIXIBLE AIR.

Fixible, or Mephitic Air, is undoubtedly very largely contained in many Mineral Waters. But whatever doubt there may be concerning common air, we can have none, that many Mineral Waters are largely impregnated with fixible air. The sparkling appearance, joined with a poignant taste, and exhilarating, and even, if largely taken, intoxicating effects, is a great evidence of this. Chemical experiments farther confirm this inference, which is drawn from their sensible qualities. The calcareous earth is precipitated from lime water by admixture with several waters, when first taken up from the spring, but if suffered to stand some time exposed to the air, before the lime water is added, no such effect is observed to take place. I have likewise remarked, that some Mineral Waters, and even their vapour, act very powerfully in corroding iron, which is a quality

Fixible
Air.

quality of fixible air. This is, indeed, so likewise of the volatile vitriolic acid; but I am rather inclined to attribute it, in many that I have taken notice of, to fixible air, since I observed that copper, equally exposed to the action of the water, was not in the least affected. Now fixible air acts very powerfully upon iron, but has not any effect on copper *, whereas the volatile vitriolic acid dissolves both very plentifully. Moreover, I have seen this effect where there was no reason to suspect the presence of the acid, which, though a possible, is nothing near so frequent an impregnation as fixible air. It is probable that the ancient fountain Salmacis, mentioned by Ovid, was of this nature, and contained fixible air in large quantity, as the descriptions of its effects answer nearly to those produced by fermented liquors.

*Quis si faucibus hausit,
Aut furit, aut mirum patitur gravitate soporem.*

Plutarch, in his Life of Lyfander, likewise mentions a fountain near Haliartus, in Greece, called Cissuffa, in which they

* Vide Note, p. 133.

say Bacchus was washed immediately after his birth, as the water is of a bright colour, tastes like wine, and is very pleasant; all which qualities are applicable to waters impregnated with fixible air, and I believe to no other impregnation. Herodotus and Polybius mention instances of a like kind. It now remains to be accounted for, by what means Mineral Waters become thus impregnated.

And here I must observe, that on the union of all the acids with alkaline salts, or absorbent earths, in their mild state, a considerable quantity of this air is discharged. If this happens in a place to which the outward air has not access, it remains united with the * water, with which the solvent is diluted. On exposure to the atmosphere, however, the fixible air rises in great quantity, in form of bubbles, through the body of the fluid, being powerfully attracted by the common air, which, in the opinion of some eminent modern Chemists, serves as

* As no decomposition seems to take place except the common air is admitted, it is more probable that the fixible air remains united with the alkali or calcareous earth, as long as the common air is excluded. Vide Experiment, p. 142, Note.

a menstruum to the fixible. This may account for the impregnation of the compound saline springs in this manner, as we may suppose the union of the acid with the alkali, or with the absorbent earth, to be formed in the earth, which would give occasion to the separation of the fixible air, which, so long as the communication with the atmosphere was precluded, would remain quiet in the water; but on the spring's breaking out, would, in consequence of its strong affinity with common air, and less specific gravity than the water, rise from all parts of the fluid, in which it was contained. To this might be attributed the sparkling appearance, pungent taste, and smell of many Mineral Waters. But notwithstanding the speciousness of this theory, it labours under several objections. Were it true in its full extent, we might expect to see waters impregnated with fixible air, in proportion as they contain a greater or less quantity of compound saline substance, from which the air had been discharged, as in the formation of a neutral salt by an acid and an alkali. Notwithstanding this, we see several springs that contain neutral saline matter in great abundance, and some even to a saturated solution, very lightly,
if

if at all impregnated with fixed air. This would seem at once to overturn the above theory, but perhaps even this admits of an explanation. The salts that are found thus, are common salt, Glauber's salt, and the earthy salt, called *Sal cath. amar.* The first of these we have great reason to believe to be an original substance, and that its component parts never existed native separately in the earth, but that they were originally produced combined in the form we see them, viz. common salt; and there are some reasons to induce us to think this not improbable of the *Sal cath. amar.* and Glauber's salt.

On supposition, however, that it might be formed in the earth by the union of an acid with an alcali, the air thus generated might be absorbed by other fossil bodies, many of which attract it before the spring had access to it, or at least by some substances it might meet with in its passage to the surface. Were this true, it would account for this circumstance, as we could not expect to see springs thus impregnated with air unless some new saline combination was directly formed by
some

some of the means above mentioned in the waters.

*Might not this be
explained from the union
of 7: & 4: which is
contains much: H:
A: & is by such an
union is sparingly
solub: in water.*

A still greater difficulty occurs; the foregoing method might serve to account for the union of fixed air with Mineral Waters impregnated with truly saline, or earthy saline bodies; but will not account for its existence in those waters, many of which we see contain it in large proportion, which have scarce any admixture of these substances, or, indeed, any discoverable impregnation.

It is undoubtedly found in many springs, where we cannot account for its presence by any reasoning drawn from any analysis of the water. So far, however, we may venture to suggest, that as this substance is found frequently native in subterraneous caverns, it is probable the springs thus impregnated, passed through some of these, where they were united together, which may be easily imagined, as they seem to have some degree of attraction for one another.

The last substance of this kind that remains to be considered is,

IN-

INFLAMMABLE AIR.

This is produced during the union of of several metals with acids, particularly zinc and iron with the vitriolic acid. It is likewise said to be generated during the solution of tin in its proper menstruum, (*aqua regia*;) and likewise by putrefaction. But as the two latter means never occur below the earth, it is needless to consider them. The only two means, then, that we can account for its production, are by the junction of the two first mentioned metals with acids. It is very probable, that it may be generated by other means, but those are not yet come to our knowledge.

Inflam-
mable
Air.

I know no variety in the kinds of this aërial substance, whether that produced on addition of zinc to the vitriolic acid varies from that generated when iron is used. If Mr. Cavendish's ingenious theory, that it is the phlogiston of metals, be just, it should seem probable, that it is of one kind only, as all inflammable substances are found to revive or restore the phlogiston to all metals indiscriminately.

The

The same ingenious Gentleman has, indeed, delivered it as his opinion, that this substance is not miscible with water. If this were once proved, it would be needless to consider it in this place any farther. I agree with that learned Gentleman entirely, in thinking that it does not admit of any intimate or chemical union with water, as both common and fixible air seem to do in some degree. But nevertheless, I find by experience, that it is capable of being mechanically united, or entangled in a watery fluid, so as to have a very perceptible effect on its sensible qualities. I am well persuaded of the possibility of this substance * occurring in the subterraneous regions, and that it may sometimes form an impregnation of Mineral Waters. I am greatly inclined to suspect, that it is frequently mistaken for fixible air. It imparts a similar pungency, but separates sooner, and the vapour of it does not precipitate lime water in the manner that fixible air does.

* This appears from the inflammable damps so often met with in mines, and other subterraneous places, which are only collections of inflammable air.

It is the opinion of a celebrated Chemist, that this is not a simple substance, but compounded of fixed air and an acid. Many arguments may be brought in favour of this opinion; but the present work will not admit of any disquisition not immediately connected with the subject. Whether this opinion be well founded or no, is not here very material, since it is always met with in the same state, as far as we know, below the earth. From its frequency there, and its possible miscibility with water, though that is only in a state of diffusion, I think it may be properly admitted into the catalogue of native impregnations.

AERIAL IMPREGNANTS of MINERAL WATERS.

- | | | |
|------------------|---|---|
| Common Air, | { | 1. In intimate union. Q. Whether solution or mixture? |
| | { | 2. In way of diffusion, as when entangled in its fall from a pipe. |
| Fixible Air, | { | 3. Q. If intimately united by dilution, or mixture, or by diffusion only? |
| Inflammable Air, | { | 4. In a state of diffusion only, as I think. |

O

From

From the aforesaid review of the Impregnations of Mineral Waters we find, that they may all be divided into those impregnated with

Saline Bodies.	Simple,	Acid.	1. Vitriolic acid <i>per se</i> .
		Alkali.	2. Fossile alkali <i>per se</i> .
			3. Volatile alkali <i>per se</i> . — Very dubious.
	Compound,		4. Glauber's Salt.
			5. Vit. ammon. very dubious.
			6. Common Salt.
			7. Sal ammoniac, very dubious.
Inflam-mable Bodies.	Oil.	Simple,	8. Oil fossil <i>per se</i> .
		Comp.	9. Oil in form of soap.
	Sulphur	Simple,	10. Sulphur <i>per se</i> .
		Compound,	11. Hep. sulph. with an alkali.
			12. Hep. sulph. c. calce vivâ.
Metallic Bodies.	Base Metals.	Copper,	13. Vitriolic acid in form of blue vitriol.
		in a state of solution by	14. Fixt vitriolic acid in form of green vitriol.
			15. Vol. vitriolic acid, as in many chalybeates.
			16. Hep. sulph. with an alkali.
			17. Hep. sulph. with quicklime.
	Semi-metals.	Iron.	18. Fixible air.
		Zinc.	19. Vitriolic acid in form of white vitriol.
	Simple,		20. Calcareous earth in solution, by being deprived of fixible air.
			21. ———, by being united with it in over-proportion.
			22. Calcareous, in form of selenites.
			23. Magnesia. — Spurious Glauber's salt.
			24. Earth of alum — in form of alum.
Aërial Bodies.	Common Air.		25. In solution, or mixture?
			26. In diffusion.
	Fixible Air.		27. Q. In solution, diffusion, or mixture?
	Inflammable Air.		28. Probably only in diffusion.

Dif-

*Different TEMPERATURE of MINERAL
WATERS.*

Besides the differences that arise from impregnations, Naturalists make a division of Mineral Waters from their difference of temperature into the *Acidulæ* and *Thermæ*.

The last of these have been the subject of much enquiry among the Philosophers, and are still very indifferently accounted for. Naturalists, finding that the pyrites, on being moistened with water, acquired a considerable degree of heat, have been willing, from this admixture, to account for both the impregnation and heat together.

Sulphur and iron filings generate heat still more considerable; and to this cause they would attribute earthquakes, and volcanoes. But there are many objections, that will destroy, or supersede, the first theory; for we have accounts of *thermæ* without any degree of impregnation. But even supposing the heat to be communicated to a neighbouring stream that is unimpregnated, we cannot imagine that such a cause should act with such uninterrupted uniformity, for such a length of time, as these

O 2

seem

seem to do, since even *Ætna* and *Vesuvius* have long intervals of seeming quietude. For these reasons, a celebrated Professor at Edinburgh seems to think, that they owe their origin to a different cause, *viz.* to an internal subterraneous heat and fire, so much spoken of by Philosophers. This circumstance, he thinks, favours that opinion, and could its existence be absolutely proved, we might then account for the production of many fossils, which we perceive to be strongly marked with evidences of such a forming cause.

In order to explain more fully what is said in the preceding book, and the two following, I have subjoined a short table of Attractions, taken chiefly from that delivered by Dr. Cullen, and printed by Dr. Saunders, in his Syllabus, with some few alterations from Dr. Lewis.

This table is to be thus understood. The substance placed at the head of each series has the greatest attraction to or affinity with that immediately below it; a less affinity with the next, and so on, to the end of the series; that so, if any of the remote bodies has been combined with the
upper-

uppermost one, the addition of any of the intermediate bodies will disunite them, the intermediate body throwing out the remote one, and uniting itself with that placed uppermost. Thus in the first column of *Acids in general*, a fixed alkali being placed between the *Acids in general* and quick-lime, denotes, that if an acid was united with quick-lime, the addition of a fixed alkali would separate the quick-lime from the acid, the alkali taking its place.

This table is not very extensive ; but, it is hoped, will serve the present purpose of illustrating the experiments on Mineral Waters.

TABLE of ATTRACTIONS.

I.

Acids in general.

* Phlogiston.

Fixt Alkali, *caustic*.— — —, *mild*.

Quick-lime.

Magnesia.

Calc. Earth, *mild*, as

Chalk.

Vol. Alkali, *caustic*.

Base Metals.

Vol. Alkali, *mild*.

Earth of Alum.

Pure or precious Metals.

* There is some doubt concerning the universality of the propriety of placing Phlogiston above Fixt Alkali. It is true of the Nitrous and Muriatic Acid, and probably of the Vegetable, since any inflammable substance will decompose any of the compound Salts made with these Acids. In the Vitriolic, too, it seems to hold, as any inflammable Substance will decompose Vitriolate Tartar, and form with its Acid a Sulphur; but, on the other hand, Alkaline Salts added to Sulphur, change its nature, and, in some measure, decompose it, as when heat is applied in this case, the Phlogiston flies off separate, and leaves the Acid and Alkali united.

II.

Vitriolic Acid.

Phlogiston.

Fixt Alkali, *caustic*.— — —, *mild*.

Quick-lime.

† Magnesia.

Calc. Earths, *mild*.Vol. Alkali, *caustic*.

Zinc.

Nickel.

Cobalt.

Iron *.

Copper.

Silver.

Tin.

Lead.

Mercury.

Vol. Alkali, *mild*.

Earth of Alum.

* Iron and Copper vary in their relative Attraction to Acids, according to the difference of heat, or of cold. In the cold, Iron attracts stronger than Copper. When heat is used, Copper attracts Acids more powerfully than Iron.

III.

† Sp^r Sal: Amm
E: Cal: viv: adden
to a solut: of Sal:
Cathar: amar: in
causd an immediate
precip: tat: The
same happen: w:
addd to a solut: of
Magn: in O₂

TABLE of ATTRACTIONS.

199

III.

Nitrous Acid.

Phlogiston.
 Fixt Alkali, *caustic*.
 — — —, *mild*.
 Quick-lime.
 Magnesia.
 Calc. Earth, *mild*.
 Vol. Alkali, *caustic* *.
 Zinc †.
 Lead, or Tin.
 Iron.
 Bismuth, or Antimony.
 Copper ‡.
 Arsenic, or Earth of Alum.
 Mercury.
 Silver.
 Platina.

* Some place Volatile Alkali above Magnesia.

† Sir Isaac Newton placed them thus:	Dr. Lewis has placed them thus:
Zinc.	Zinc.
Iron.	Iron.
Copper.	Copper.
Silver.	Lead.
Tin.	Mercury.
Lead.	Silver.
Mercury.	

‡ Perhaps Volatile Alkali *mild* should be placed here.

IV.

Muriatic Acid.

Phlogiston.
 Fixt Alkali, *caustic*.
 — — —, *mild*.
 Quick-lime.
 Magnesia.
 Calc. Earth, *mild*.
 * Vol. Alkali, *caustic*.
 Zink.
 Iron †.
 Tin.
 Regulus of Antimony.
 Copper.
 Lead.
 Silver.
 Mercury.
 Gold.

V.

Vegetable Acid.

Phlogiston.
 Fixt Alkali, *caustic*.
 — — —, *mild*.
 Quick-lime.
 Magnesia.
 Calc. Earths, *mild*.
 Volat. Alkali, *caustic*.
 — — —, *mild*.
 Zinc.
 Iron.
 Tin.
 Copper, or Antimony.
 Lead.
 Silver.
 Mercury.

* Perhaps the Volatile Alkali should be placed lower.

† Some place Iron next below Tin.

TABLE of ATTRACTIONS.

VI.

Alkaline Salts.

Vitriolic Acid,
 Nitrous Acid,
 Muriatic Acid.
 Vegetable Acid.
 Volat. Vitriolic Acid.
 Acid of Borax.
 Oil *.
 Sulphur.

VII.

Calcareous Earth.

Vitriolic Acid.
 Nitrous Acid.
 Muriatic Acid.
 Vegetable Acid.
 Fixible Air †.
 Sulphur.

* I imagine Fixible Air should be here inserted between the Acid of Borax and Oil.

† I have placed Sulphur below Fixible Air, on the authority of Mr. M'Bride, who has found Fixt Air to precipitate Sulphur from a Solution of Hep. Sulph. c. cal. vivâ, though I own I rather doubt it.

VIII.

Fixible Air.

Calces of Metals *.
 Quick-lime.
 Fixed Alkali.
 Magnesia.
 Volatile Alkali.

IX.

Pblogiston.

Nitrous Acid.
 Vitriolic Acid.
 Metallic Substances.
 Fixt Alkaline Salts.

X.

Sulphur.

Fixt Alkali, *caustic*,
 ———, *mild*.
 Quick-lime.
 Iron.
 Copper.
 Lead.
 Tin.
 Silver.
 Antimony.
 Mercury.
 Arsenic †.
 Volatile Alkali.

† * The superior Attraction of Fixible Air to Calces of Metals is shewn by a mild Calcareous Earth, being sufficient to reduce several of them into their metallic form without the addition of any Inflammable Substance.

† Some place the Volatile Alkali between Mercury and Arsenic.

XI.

‡ In R 223. Calc. Earth is said to attract fixt air to a certain proportion stronger than any Body we are acquainted with.

TABLE of ATTRACTIONS.

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XI.

Lead.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.
Oil.

XII.

Iron.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.

XIII.

Antimony.

Vitriolic Acid.
Nitrous Acid.
Muriatic Acid.
Vegetable Acid.

XIV.

Copper.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.

XV.

Mercury.

Muriatic Acid.
Vitriolic Acid.
Nitrous Acid.

PART

. P A R T II.

HAVING thus determined the nature and qualities of the several substances contained in Mineral Waters, I shall now give a short sketch of the most approved means to be used for discovering these impregnations.

And here it is not proposed to attempt an account of the effects of every experiment used on these occasions with each of the impregnations, but to select such only as may most effectually serve to discover their contents.

I shall take these in the order they are presented in the foregoing Table.

C H A P.

C H A P. I.

S A L I N E S U B S T A N C E S.

S E C T. I.

S I M P L E.

WATERS of this kind are sometimes so strongly impregnated as to be discoverable to the taste by their acidulous tartness. They change the colour of the vegetable blues to a reddish* cast, effervesce with all the alkaline salts, or calcareous earths, and with †magnesia when these substances are in their mild state, or united with fixible air, and on evaporation, leave a salt which has the vitriolic acid for its acid basis, but which may be either of the neutral or earthy

PART II.

Vitriolic
Acid *per se*.

* It may be thought extraordinary to make this a test of the presence of the vitriolic acid, which has been before mentioned, as being present here in its volatile state, in which it destroys all vegetable colours whatever. But I find that this acid, when very largely diluted with water, as it always must be in springs, becomes in some degree fixed, and changes the vegetable blues, red. In distilling vitriolic acid, the operators find, that a small quantity of water in the receiver is of service, by rendering the acid more fixed.

† *Vide* Essays, Physical and Literary, Vol. II. p. 174.

kind,

PART II. kind, according to the substances which were added in the experiment.

They precipitate all solutions made in alkalines, curdle soap, or render a solution of it in rectified spirit milky. A solution of sulphur in water made by means of alkalies is precipitated, and rendered milky by these waters, and emits at the same time a strong foetor. Dr. Lewis has mentioned the same effect as produced on the solutions of sulphur made by means of quick-lime. This is true of a very strong or nearly saturated solution of sulphur made by these means, but will not hold good of a dilute one, which is not visibly affected by acids. They produce a cloudiness with the solutions of silver, lead, and mercury, in the nitrous acid; with the two first, of a whitish colour, (though not in near so great a degree as that with the muriatic acid;) and with the last, the precipitation soon acquires a yellowish tinge. Such are the general characters of these waters. Some of them, nevertheless, are not peculiar. Waters containing alum effervesce with alkaline salts, precipitate the solutions of silver and lead in a whitish cloud,

cloud, and that of mercury in a yellowish one, and change the colour of the vegetable juices. PART II.

In order to supply this defect, the learned Dr. Lewis recommends to distil the water whilst fresh, and then examine if what comes over in distillation has this effect on the vegetable blues. He alledges, that if this be the case, we may be assured of the presence of an acid unneutralized, as the neutral or earthy salts which produce this effect, do not rise in distillation.

This Theory of the Doctor's is very ingenious, and I wish I could pay an entire credit to it, as it would afford an easy method of discovering the presence of this substance in waters. I will, however, venture to suggest a circumstance, which makes me doubt if this be so clear a test as that learned person seems to imagine.

The ingenious Dr. Percival, in his Essay on Water, has demonstrated, that the vitriolic acid, when the salt containing it is in a state of solution in water, (as in this case might often happen with so common an impregnation as selenites,) is separable by a boiling heat, and that by these means the
hardest

PART II.

hardest waters that owe this quality to that substance, might be rendered soft. It is probable, therefore, that this would happen in distillation, and the vitriolic acid be thus forced over into the receiver, and impregnate the distilled liquor in sufficient quantity to produce this effect on the vegetable blues, although it had never existed originally in a separate state in the spring. It is doubtful if the vitriolic acid does not arise in a volatile form from selenites, which would render this still more probable.

This opinion is confirmed by the appearances observed on the distillation of sea water, where a small quantity of the vitriolic acid (which is always present in it) comes over into the receiver, unless a quantity of fixed alkaline salt, or calcareous earth, be added to it, previous to its being committed to distillation.

The following seems to be the more certain method of determining the presence of this substance, *viz.* to observe first, if the effervescence caused by addition of mild alkaline salts, magnesia, or calcareous earths, and the change of vegetable blues to red, does not cease to be produced

produced on the waters standing exposed to the air. Secondly, if any precipitation happens on addition of a mild calcareous earth, or magnesia. The first of these is a pretty certain mark of the presence of an unneutralized acid, as the vitriolic acid, when in its separate state in Mineral Waters, is always in a considerable degree volatile. Were these effects produced by alum, or any metallic salt, dissolved in the waters, they would be more permanent in them. If no precipitation happens through the body of the liquor, on addition of a mild * calcareous earth or magnesia, but an effervescence ensues without any change of colour, it may be taken for granted, that an acid is present in its separate state ; as was it united with earth of alum, iron, copper, or any other metallic substance, some precipitation or change of colour would happen on such addition.

* If this be used, care should be taken to use it very sparingly, as the compound saline substance formed, is so difficultly soluble in water. Perhaps, on this account, magnesia would be the properest test.

PART II.**Fossil
Alkali.**

Waters containing the fossil alkali effervesce with all the acids, and form thus neutral salts, according to the different acids added to them, change the vegetable blues to green, and precipitate the solutions of calcareous earths, or magnesia, in any of the acids, and of the ammoniacal salts and alum in water.

They render milky the solutions of silver, lead, and mercury, in the nitrous acid, and precipitate the iron from the vitriolic, nitrous, and muriatic, in form of a yellowish brown ochre. Dr. Lewis recommends as the most certain mark of this substance, to observe if the water containing it effervesces with the muriatic or vegetable acids. This is certainly a good criterion with respect to those saline bodies into whose composition the vitriolic acid enters, as these would not be decomposed by addition of the muriatic or vegetable acids, but will not hold universally, as waters containing calcareous earths in a diffused state (or, if Mr. Cavendish's ingenious Theory be true, dissolved by an over proportion of fixed air,) would exhibit the same appearance, although they contain no alkali.

In

In my opinion the best test is to examine the residuum left by such waters on slow evaporation. This, if the fossil alkali was contained in the water, will be in part soluble again in the same fluid, and will then, if but a small quantity of water is added, manifest itself by its urinous taste, by its change of vegetable blues to green, and by its effervescence with acids, which might be not discernible when diluted so largely as this substance sometimes is in Mineral Waters. PART II.

* A precipitation is occasioned in waters of this kind, by addition of a solution of chalk or magnesia in the nitrous or muriatic acids. This circumstance, joined to that mentioned by Dr. Lewis, affords a

* Dr. Lewis has said, that solutions of calcareous earths in water, lime water for instance, decomposes neutral salts, formed by an acid and alkali, *e. g.* Glauber's salt, (*Vide Neumann's Chem. p. 176.*) I have repeated this experiment, but always found the contrary effect, as the alkali added to an earthy salt, produced a decomposition; but an earth added to a neutral, produced no change. Glauber's salt or vitriolic tartar cannot be decomposed by any simple substance, but only by a double elective attraction, as in the case of solution of silver in the nitrous acid, and of earths in the nitrous or muriatic.

The Doctor himself, in another part of his Work, has confirmed what is here laid down. (*Vide Neumann's Chemistry, p. 252.*)

P

reasonable

PART II. reasonable presumption of the presence of an alkali, as the calcareous earth before mentioned would cause no precipitation.

S E C T. II.

S A L I N E S U B S T A N C E S.

C O M P O U N D.

Glauber's
Salt.

Waters containing Glauber's salt in large proportion, are easily distinguished from those that possess other impregnations, by the bitterish saline taste that accompanies them. But it is sometimes present in too small a proportion to be obvious to the taste. On evaporation, notwithstanding it is discoverable by its chrystals, which are large and well formed, of an hexagonal prismatic form, when perfect and truncated at both ends.

They are of very easy solubility in water, and calcine in a dry air. On evaporation the impregnation manifests itself to the taste, though when largely diluted, it was not perceptible. These waters cause no change on the colour of vegetable blues, and afford no precipitation on addition of alkaline, or acid substances, in which they differ

differ from waters impregnated with sal cath. amarus, which shew a precipitation on addition of an alkali, though in other respects, as taste, shape of chrystals, and easy solubility, they much resemble this. Solutions of lead and silver in the nitrous acid are precipitated in form of a yellowish white cloud, and that of mercury in the same acid, in an orange coloured one. Moreover, Glauber's salt melts easily in the fire, whereas the other can scarce be fused by the most extreme heat.

The brackish taste of many waters frequently discovers the presence of this substance. It is, indeed, present native in most springs, though not in quantity sufficient to be thus detected. It differs from the former, by its not having the bitter taste which accompanies the Glauber's salt and sal cath. amarus. But the surest test of it is, to examine the shape of the chrystal yielded on evaporation. These are always cubical, which distinguishes them from all other native substances found in Mineral Waters, as none of them assume that form on crystallization. It is not affected by alkaline substances, but on ad-

Common
Salt.

PART II. dition of the vitriolic or nitrous acids, a decomposition takes place, and the salt loses its native taste and qualities, and assumes those of Glauber's salt, or cubic nitre. It precipitates the solutions of silver, lead, and mercury in the nitrous acid, the most suddenly and largely of any substance, in form of a white cloud, which soon falls to the bottom, and may be collected by itself, and proves to be the muriatic acid of the sea salt, separated from its alkaline basis and united with the silver. It does not affect the colour of vegetable blues.

C H A P. II.

INFLAMMABLE SUBSTANCES.

Fossile
Oil.

THIS comes next in order, and is easily distinguished by the taste and smell of the waters that contain it, both of them being very acrid, and peculiar to this substance only. When in this state they are distinguishable to the eye, the oil not being mixed with the water, but floating

floating on its surface. It is generally, PART II.
when thus found, of a brownish colour,
and thick consistence, when it is called
petroleum, though sometimes it appears
clear and colourless, when it is termed
naptha. Those wells are of this kind that
take fire on application of a burning body
to their surface.

These waters possess the same qualities
with the above-mentioned, except that here
the fossil oil is more intimately united with
the water by mediation of an alkali. It is
discovered by addition of acids which im-
mediately separate the oil, and leave the
water clear.

Oil united
with wa-
ter in form
of soap.

This is discoverable by the taste and
smell of the waters that contain it; by
examination of the precipitate it lets fall
on standing, which sometimes, as at Aix
la Chapelle, lines the pipes that convey it.
This, if sulphur, may be easily distinguished
by its taste, smell, and inflammability, by
the waters striking a black colour with so-
lution of sacch. saturni in water, and solu-
tions of lead in the nitrous acid; by their
sudden tarnishing of silver; by the fœtid
smell, resembling a rotten egg, or scower-
ing

Sulphur
per se.

PART II. ing of a foul gun barrel, on addition of alkalies; by the taste attending this addition; all which circumstances point out this substance very clearly.

Hepar
Sulphuris
with an
alkali.

The taste and smell of these waters are so remarkable, as scarce to leave any room to doubt the impregnation, when they are present. They resemble, as was said before, a rotten egg, or scowering of a gun barrel; in the latter of these, this substance is always generated on the inflammation of the gunpowder, the acid of the nitre being dissipated, and the vitriolic acid of the sulphur, joined to the phlogiston acquired from the charcoal uniting with its alkaline basis, and forming this substance.

Waters impregnated thus, strike a black colour with solution of lead in the nitrous acid, and with a solution of Sacch. Saturn. in water from whence the sympathetic ink is derived. They tarnish silver suddenly and deeply; become milky, and emit a strong fœtor on addition of acids; by which they differ from the last mentioned, as the sulphur being there in a diffused state, is not affected by acids. The former, too, is not distinguished by the taste and odour
above

above mentioned, which is peculiar to PART II. this.

It differs likewise that this, though in part decomposed by exposure to the air, and, as Dr. Cullen thinks, by solution in water, yet retains its qualities in a great degree, when kept from the air a considerable time; whereas, the other soon suffers a precipitation of all its contents of this kind.

This, though nearly allied to the former, exhibits very different appearances, on experiment. A weak solution, such as we generally see in Mineral Waters, is not affected by acids; and though the strong solution be disagreeable to the taste, the dilute one is not unpalatable, having nothing of that peculiar smell and taste resembling a putrid egg, or scowering of a gun, which so eminently distinguishes the other. It is decomposed by exposure to the air, and solution in water, as the hepar. sulph. with alkali is, and on standing, even shut from the air, suffers a precipitation. It strikes no black colour with solution of lead in the nitrous acid, or of sacch. saturni in water, and scarce even precipitates them

Hepar
Sulphuris
with
Quick-
lime.

*It is likewise
decomposed & pre-
cipitated by
fixed air, which
the foregoing is not.*

PART II. or the solution of silver. It is precipitated by all the alkalies both fixed and volatile, which the former is not. It has no effect in tarnishing silver.

C H A P. III.

METALLIC IMPREGNATIONS.

Copper.

WATERS of this sort are sometimes obvious to the taste, which is, indeed, able to discover a very slight impregnation of this kind. Thus we see waters that have stood in copper or brass vessels gain what is called a brassy taste, though the quantity dissolved can scarce be measured. The most certain test of the presence of this metal, is the addition of the caustic volatile alkali, as *sp. sal. amm. cum calce viva*. This, if the smallest particle of copper be dissolved, causes the whole of the fluid to assume a beautiful blue colour. Iron also precipitates this metal. On addition, therefore, of a plate of iron to any waters containing copper in solution, it will
soon

soon be covered with a crust of this metal; PART II.
and if it be laid in the current of the spring, will in time be entirely changed into it. This has given room for some, who did not understand the nature of precipitation, to imagine that the iron was really transmuted into copper; whereas no more happens than the simple precipitation of the copper, occasioned by the vitriolic acids that held it, dissolved, having a greater affinity with iron than copper. A proportionable quantity of iron is, therefore, dissolved in place of the copper precipitated, which always happens on the surface of the precipitant, so that in time the whole is dissolved, and a portion of copper substituted in its place. It is observable of metals, that they always precipitate each other in their metallic form. If waters contain copper in any considerable quantity, it may be discovered by crystallization.

Chalybeate Waters are generally discoverable to the taste by their peculiar astringency. Where the quantity dissolved is very small, this is not perceptible. Springs of this kind are easily distinguished by the ochrous sediment which is constantly precipitating

Iron;

PART II. cipitating from them, and which gives a yellow colour to all the substances exposed to their current. The principal and best known test of them is the black colour they strike with the vegetable astringents, and a purple one when an alkaline salt or lime water is added to the astringent. Dr. Percival has asserted, that the ferruginous waters will not strike a black or purple with many of the vegetable astringents, without the addition of lime water, and has, indeed, brought several experiments in proof of what he has alledged. The addition, however, of these substances, makes this experiment tolerably satisfactory, and enables us to discover a very minute portion of iron in the water.

Some of the mineral astringents, as alum, likewise precipitate this metal in form of a reddish yellow ochrous sediment, which, on addition of an inflammable body, and a small degree of heat, may, like the foregoing precipitation, be again reduced into iron. Zinc is the only metallic substance that is known to precipitate iron, which it does in form of a brownish powder. The same is said of nickel by some, but

but this is not proved. It is observable, PART II.
that all the solutions of iron by native substances, as by acids, the two kinds of hepar sulphuris and fixed air, strike a black colour with vegetable astringents. Care must be taken to make these experiments with the waters when fresh from the spring, as on standing, they lose these qualities.

So much for chalybeates in general. As to the distinguishing the varieties of these, those formed by green vitriol are discoverable by their retaining their power of striking black with astringents a considerable time, by their effervescing with mild calcareous earths, and at the same time letting fall a brown precipitation, and when largely impregnated, by their exhibiting crystals of green vitriol on evaporation. The liquor, likewise, when nearly evaporated, gives a red tinge to the vegetable blues.

Varieties
of chaly-
beates.

Green Vi-
triol.

Those formed with the volatile vitriolic acid, are distinguished from the former by the quick precipitation of the iron from them, and from those formed by fixible
air,

With vol.
vitriolic
acid.

PART II. air, by the effervescence* observable on addition of calcareous earth, or magnesia, in a mild state, which does not happen in chalybeates of the latter kind.

With hep-
par sulph.
with an
alkali.

For the distinction of hep. sulphur. with an alkali, *vide* chap. on inflammable substances, Book II. Chalybeates formed by these means give no ochrous precipitation on addition of an alkaline salt.

With hep-
par sul-
phuris
with
quick-
lime.

Chalybeates of this kind are distinguished from the foregoing, by their giving an ochrous precipitation, with caustic alkaline salts, but none with lime-water. For the method of discovering this kind of hep. sulph. *vide* chap. on Inflammables.

With fix-
ible air.

These chalybeates are distinguished by their quickly losing their qualities when exposed to the air, by their shewing no effervescence with mild alkaline salts, and by the other marks which indicate the presence of fixible air, for which *vide* chap. V. of this Part, on the means of discovering Aërial Impregnations.

* In this case a precipitation happens, but the iron is sometimes re-dissolved by the fixible air, set loose from the earth by the acid.

This substance has hitherto been so little suspected to be present in Mineral Waters, that we have had very few experiments made on the appearances it assumes on addition of other bodies. It is always found in Mineral Waters dissolved by the vitriolic acid in form of white vitriol. It may be discovered on crystallization by its taste, which is nauseous, sweetish, and styptic, and by the form and colour of its crystals, which are pyramidal, parallelopipeds, and sometimes transparent, though generally of a dusky yellowish hue, from the ochre of iron they contain in the state we find them. Moreover, if any of the suspected crystals be mixed with equal weight of calcareous earth, and double their weight of charcoal dust, made into a paste with oil, put between two plates of copper, and then placed in a moderately hot furnace for a short time, the zinc will discover itself, by changing that part of the copper* into brass, which comes into contact with it.

PART II.

Zinc.

* This must be carefully distinguished from the whiteness communicated to copper by a small quantity of arsenic. They differ in this, that arsenic renders the copper extremely brittle, which zinc does not.—This is only meant as a caution, and not to insinuate that arsenic was ever known to be found in any Mineral Waters.

C H A P. IV.

EARTHY IMPREGNATIONS.

S I M P L E.

CALCAREOUS EARTHS.

PART II.Calcareous Earth.

THE calcareous earth is the only one we find in its simple state united with water in quantity sufficient to bring it under the foregoing definition of Mineral Waters. If this be dissolved by being deprived of its air, all substances that supply that substance will precipitate the earth in large quantity. Waters of this kind must then be precipitated by all the means that lime water is precipitated, *viz.* by the air arising from effervescent mixtures that generated in fermentation, and that emitted from the lungs of animals in breathing. If Mr. Cavendish's theory of the solution of calcareous earth, by being united with an over proportion of fixible air, be just, then the earth will be precipitated by all substances that attract the superabundant quantity, which, according to that theory, does

does not appear strongly attached to the earth, although the same earth attracts fixible air to a certain proportion, the most powerfully of any body we are acquainted with. The addition, therefore, of lime water, or the caustic alkali, will precipitate the calcareous earth from the water. If the former be used, it will be necessary to compute the quantity of earth contained in the portion of lime water which is added, and to subtract that from the residuum, since the earth contained in the lime water would be precipitated also. If the caustic alkali be used, it might be apprehended that part of the residuum might be produced by the decomposition of selenites, which most waters contain, and this is true in some degree, especially if the alkali be not perfectly caustic, which is very difficult to procure. But I find that the precipitation, on addition of soap lees to the selenitic waters, is very small in comparison with that let fall when lixivium tartari is used, which difference is owing, probably, to the calcareous earth, in the first case remaining in its caustic state, and of consequence retaining its solubility in water; and in the latter, becoming mild
and

PART II.

and insoluble in water, and of course precipitating by having attracted the fixible air, let loose from the alkali on its union with the vitriolic acid, which last is one of the component parts of selenites. But I should think these precipitations might be distinguished by observing if the precipitation on addition of the caustic alkali was not larger when the water was fresh, than after it had stood some time, as the superabundant quantity of fixible air is observed to separate from the earth on standing.

If then there be a large precipitation of calcareous earth by caustic alkali when the water is fresh taken up, and scarce any after it has stood some time, I should think it a general argument to prove, that it contained calcareous earth in the manner supposed by Mr. Cavendish. If the water contain calcareous earth in form of quick lime, such waters will unite easily with soap, but whether that would be so in the latter instance, I have some doubt, as fixt air has the power of separating the oil from the alkali, and, it is probable, that in consequence of this quality, that some waters refuse to unite with soap at their first rise, which, after standing some time
exposed

exposed to the air, do it very easily. PART II.
This change may, with great probability,
be attributed to the escape of the fixible
air.

COMPOUND EARTHY IMPREGNATIONS.

This, as before observed, is a very frequent impregnation. It is discovered by the refusal of these waters to unite with soap, and by their throwing down a large earthy precipitate on addition of a mild alkaline salt. On evaporation, likewise, it is distinguishable by the form in which it crystallizes, being in thin laminae, which form a pellicle on the surface of the liquor, and by the taste of the salts and water containing them after a pellicle is formed, which is lightly saline and austere. We should however be cautious not to mistake the waters impregnated thus, for those containing calcareous earths in substance; as they leave nearly the same residuum on boiling; by the decomposition of the Selenites they may be distinguished, in that both the latter soon deposit their earth, on standing exposed to the air some time, which is not the case with these waters.

Selenites;

As Selenites is so very sparingly soluble in water, the precipitate must of course be very small.

Q

This

PART II.

Spurious
Glauber's
Salt.

This is not liable to be confounded with any other substance, except the true Glauber's salt. The method of distinguishing them is given above in the account of that substance.

Alum.

Waters, containing alum, discover themselves, on evaporation, by their austere astringency. They change vegetable blues to red, and coagulate milk.

The taste of selenites, though rather austere, is very distinguishable from alum, by its inferiority in strength, as the former is very sparingly soluble in water. We have, however, a more certain method of discovering the presence of alum, which is, to evaporate the water until it becomes perceptibly saline, when, if we add a few drops of lix. tart. or any other fixed alkaline salt, the alum will be precipitated, not as other earths are, (in a powdery form,) but in floculi. If but a small quantity of alkali is used, these will be re-dissolved, which arises from the nature of alum, which is the only salt we know that has a super-abundant portion of acid adhering to it, which re-dissolves the earth of alum, precipitated by the alkali. If too much
alkali

alkali is used, the superabundant acid will be saturated, and the earth not dissolved. Dr. Lewis recommends to us to examine with vitriolic acid the precipitates of waters thrown down by addition of alkali. This, if the water contained alum, will unite with the earth thus precipitated into a highly astringent salt; if it contained magnesia, into a saline bitter one; and if a calcareous earth, into one slightly saline and astringent, and scarcely soluble in water. The crystals of alum are hexangular, and of a middle solubility, between selenites and the true or spurious Glauber's salt.

CHAP. V.

AERIAL IMPREGNATIONS.

THE presence of air in water has been observed before to be proved by the experiment of the exhausted receiver, which probably separates all substances of this kind from water. This is distinguished from the other two kinds by this, that although it separates from the water on exhausting, the air does not spontaneously fly off, nor does it precipitate the lime from lime-water when they are mixed together.

Common
air.

PART II.

Fixible
air.

This is discoverable by the sparkling appearance, pungent taste and smell, and intoxicating effects of the waters that contain it. They likewise precipitate lime from lime-water on admixture with the latter, and corrode, and even dissolve iron when fresh taken up, though they lose both these qualities on standing some time exposed to the air. The air likewise conveyed from these waters by a bended tube on the surface of a quantity of lime water will precipitate the lime from it.

Inflam-
mable air.

This separates more easily from the water than either of the two foregoing, being of much less specific gravity*. It imparts a similar pungency, but I cannot discover if it communicates any effects of the inebriating kind similar to those possessed by fixible air.

Waters of this kind differ from those which contain fixible air, in that they neither dissolve iron, nor precipitate lime from lime-water, nor is the latter of these effects produced by their vapour.

* Fixible air is heavier than common air, inflammable air is lighter.

P A R T III.

I Come now to the application of the PART III.
two foregoing Parts, to the investigation of the nature and qualities of the Bath Waters, and the circumstances in which the different springs vary from each other. But before I enter upon the Chemical Experiments necessary on this occasion, it will be proper to premise a few words concerning their sensible qualities.

EXTERNAL APPEARANCE.

Three clear glass bottles, each of a quart contents, were filled severally with the water of the King's Bath *, the Hot Bath, and the Cross Bath, then immediately closed up and set to stand. They all, when first filled, appeared at first sight colourless and

* When the Bath Waters are mentioned in the ensuing Experiments without any addition, they are to be understood of them as brought fresh from the pump, in bottles carefully corked, to a small distance, where the Experiments were made. When these were made with the water which had stood some time, or at the spring head, it is so expressed.

PART III. pellucid. But on a more accurate inspection, I could perceive many minute white *moleculæ* floating in each of them, nor could I discover, on the closest examination, which of the springs had this appearance in the greatest degree. They all sparkled in the bottle, during the filling of it, in the same manner that the Spa Water does; and I imagined, that this circumstance seemed to occur more strongly in the water of the King's and Hot Bath, than in that of the Cross Bath. After standing twenty-four hours they had all acquired some slight degree of a wheyish tinge, scarce perceivable unless by comparing them with some of the water of the same Baths fresh drawn, and I thought that this seemed rather more perceivable in the bottle filled with the water of the King's Bath, than either of the other two. They all had deposited a very slight ochrous sediment, only just perceivable in the water of the Hot and Cross Baths, but more discoverable in that of the King's Bath; though even in this the quantity precipitated was extremely small. This sediment is collected round the edges of all the Baths, but most remarkably in the King's Bath.

On

On suffering them to stand twenty-four hours longer unstopped, the wheyish tinge became more conspicuous, but no precipitation was deposited, except the slight ochrous one before-mentioned.

PART III.

O D O U R.

None of the waters have any particular smell that I could discover, either in the waters themselves, or in the vapour arising from them. Some little degree of pungency, without any distinguishing peculiarity, I have sometimes perceived, resembling that arising from effervescent mixtures, or fermenting liquors. I have perceived this, in some degree, in each of the Baths, but I think it is more discernible in the Hot Bath and King's Bath, than in the Cross Bath.

T A S T E.

These waters are all slightly saline, accompanied with an agreeable pungency, added to a light chalybeate taste. To me the King's Bath seems to possess the two last of these qualities in the greatest degree, though I have met with several, who thought them more prevalent in the Hot

Q4

Bath

PART III.

Bath water. Beyond all doubt, however, the chalybeate impregnation is most perceivable in the King's Bath Water; and I believe most people think, that the water of the Cross Bath possesses the least pungency. On cooling, the chalybeate taste and the pungency go off entirely, (though I think the Hot Bath retains both of these qualities the longest,) when the water becomes much less agreeable, the saline taste becomes more manifest, and seems accompanied with another, different from the taste of any saline body I am acquainted with, though on long standing this peculiarity of flavour goes off also. This particularity of taste appears to me most remarkable in the King's Bath, though others think it more perceivable in the Hot Bath.

T E M P E R A T U R E.

The heat of each of these waters is variously laid down. According to the best experiments I could make, the heat of the King's Bath Water, and that of the other Baths, as commonly drank, is as follows:

King's Bath	116
Hot Bath	116
Cross Bath	112

I once

I once found the thermometer raised by the King's Bath, after pumping, to 118 degrees; but I imagine that this rarely happens, so that I suppose the general heat at which they are taken scarce exceeds 116 degrees.

PART III.

CONTENTS *of the* BATH WATERS *on*
Evaporation.

Six gallons of the King's Bath Water were evaporated to about a quart. Before this, a considerable quantity of a whitish powdery substance, in part crystallized, was deposited round the edges of the vessel adjoining to the fluid, and several pellicles were formed, which successively precipitated in a laminated form. The remainder of the liquor had a taste evidently saline, but not so strongly as might have been expected, as it was proved to be at least a saturated solution from the crystallization of the saline matter. On evaporation to dryness, with a very gentle heat, there remained seven drachms and half a scruple of a substance of a dusky brownish colour, with a yellowish tinge, adhering strongly to the bottom of the vessel. The same circumstances happened in the evaporation of the
water

PART III. water of the Hot and Cross Baths as of the King's Bath, save that the residuum of six gallons of the Hot Bath Water weighed seven drachms, two scruples, and eleven grains; and that of the Cross Bath, one ounce, one scruple, and fifteen grains. The residua of the Hot and Cross Baths were of a light brown, and not by several shades so dark as the residuum of the King's Bath; and I think that, of the two, the colour of the residuum of the Hot Bath was most inclining to a white.

EXAMINATION of the several RESIDUA.

None of the residua had the least perceptible odour, but to the taste were all evidently saline; which of them were most so, I was not able to discern with any certainty; but that of the Cross Bath was evidently less so than either of the others. On examination of the several residua with the microscope, the greatest part of them appeared in a powdery form, resembling an earthy substance, and the mainder made up of cubical and small hexagonal prismatic crystals, some of them terminating in a pyramid, and others truncated.

CHEMICAL

CHEMICAL ANALYSIS *of the* RESIDUUM.

EXPERIMENT I.

Four scruples of the residuum of the PART III.
King's Bath Water were washed in repeated portions of warm distilled water, until the residuum had lost all its saline taste. Each of these portions, in all about two thirds of a pint, were put together in a china basin, and evaporated slowly over a lamp. When the water was nearly dissipated, it was taken from the fire, and set to stand in a warm place until the remainder of the moisture was evaporated; there then remained one scruple and eleven grains of a white substance, entirely crystallized, and of a saline taste, resembling common salt, and wholly soluble in water, and which, when examined by the microscope, appeared to be entirely composed of cubical crystals.

EXPERIMENT II.

The above Experiment was repeated with the residuum of the Hot and Cross Bath Waters, but no perceivable difference was observed, except in the quantity of
saline

PART III. saline substance gained, which was one scruple and nine grains from four scruples of the Hot Bath residuum, and eleven grains only from a like quantity of that of the Cross Bath, The taste and appearance of the saline substance gained was apparently the same in all.

EXPERIMENT III.

Vitriolic acid to the saline substance gained from the residuum.

To ten grains of each of these salts were added three drops of the vitriolic acid: Immediately the smell of the spirit of salt became perceivable.

EXPERIMENT IV.

Solution of silver.

To three ounces of distilled water was added two drops of solution of silver in the nitrous acid, which produced no change of colour. To this was added one grain of the cubical salt gained as above from the residuum of the King's Bath Water, when it all assumed a milky appearance.

EXPERIMENT V.

The same was tried with the saline substance gained from the residuum of the Hot and Cross Bath Waters with exactly the same event.

Ex-

EXPERIMENT VI.

To two drachms of distilled water was added six grains of the saline substance procured in Experiment I. from the residuum of the King's Bath Water. Into this solution was put a slip of paper rubbed over with the flowers of fresh violets; no perceptible change of colour could be discovered.

PART III.

Vegetable blues.

EXPERIMENT VII.

The same Experiment was tried with the saline substance extracted from the residuum of the Hot and Cross Bath Waters, with the same event.

EXPERIMENT VIII.

To one drachm of the gross residuum of the King's Bath Water was added three ounces of distilled water. To this I added twenty drops of spirit of nitre; a considerable effervescence ensued, and * a part of the residuum was dissolved, which was not

Spirit of nitre to the gross residuum.

* The nitrous acid was used here preferable to the vitriolic, because the residuum which remained undissolved was probably Selenites, which is not affected by the nitrous acid; but on addition of a superabundant quantity of vitriolic acid dissolves easily in water, although so difficult of solution

PART III. affected by water alone. But nearly one third part remained, which could not be rendered soluble by these means, although I added forty drops of the nitrous acid.

EXPERIMENT IX.

To one drachm of the gross residuum of the Hot Bath Water was added twenty drops of spirit of nitre, as in the foregoing Experiment. An effervescence ensued, but not so great as in the last Experiment, and a part of the residuum was dissolved on addition of the acid, but still could not be rendered entirely soluble, even by addition of forty drops more; nearly the same proportion remaining insoluble as in the residuum of the King's Bath Water.

EXPERIMENT X.

The above Experiment was tried with the residuum of the Cross Bath Water. In this case the effervescence was remark-

in the state we generally see it. This may, perhaps, account for its being contained more largely in some springs than its solubility in water would account for by any other means, and is, in my opinion, a presumptive evidence, that the vitriolic acid is present in its separate state in some Mineral Waters.

ably

ably less than in the other two instances, and a much larger portion of the residuum remained insoluble. PART III.

EXPERIMENT XI.

Thirty grains of each of the residua of the several Baths were laid on a red hot poker; a slight decrepitation ensued in each, but no flame or detonation was observed in any, although I added to each a few grains of charcoal, nor was any perceptible odour emitted. The colour of each of the residua was only rendered rather darker.

EXPERIMENT XII.

Two drachms of each of the residua were severally added to six ounces of water, and stirred up, and then suffered to stand about an hour. To each of these was added twenty drops of lixivium tartari, a cloudy appearance, of a milky colour, was formed in contact with the residuum in all of them, but very little appeared in any through the body of the liquor.

Lixivium
tartari to
the gross
residuum.

N. B. I repeated this Experiment, and filtered the liquors, after having let them stand

PART III.

stand some time on the residua. Lixivium tartari then made scarce any precipitation in any of them.

EXPERIMENT XIII.

Having observed a yellow ochery substance that concretes round the edges and sides of all the Baths, but most remarkably in the King's Bath, I procured some from the latter, and made it up into a paste with a little oil, and put it into a crucible placed in a hot fire, and on keeping it there a few minutes, poured it out, and, when cool, found several of its particles strongly attracted by the magnet.

N. B. I repeated this Experiment with some of the same kind of substance, procured from the Hot and Cross Baths, with the same event.

ANALYSIS *of the* WATERS.

EXPERIMENT XIV.

Lixivium
sapon. to
the Bath
Waters.

To eight ounces of the Water of the King's Hot and Cross Baths, were added twenty drops of soap ley: This caused a very considerable milkiness through the body of the fluid, in each of them.

Ex-

EXPERIMENT XV.

To eight ounces of the Water of the
several Baths, that had stood corked about
half an hour, was added a like quantity
of soap ley. A slight milky colour was
produced in all of them, which was most
perceivable in the Waters of the Hot and
King's Baths, but less than in the pre-
ceding Experiments, and when tried after
the Waters having stood twenty-four hours
was scarce perceptible.

PART III.

EXPERIMENT XVI.

To eight ounces of the Water of the
several Baths was added twenty drops of
lixivium tartari. This caused in all a
copious and sudden precipitation of a flaky
appearance, much more considerable than
in Experiment XIV. They all shewed a
reddish tinge in the precipitation, but that
was most observable in the King's and Hot
Bath Water.

Lixivium
tartari.

EXPERIMENT XVII.

To eight ounces of the several waters
was added sixty drops of spirit of sal
R ammo-

Sp. sal
ammon.
cum calce
vivâ.

PART III. ammoniac, with quick-lime. A slight milky cloudiness appeared in each, though scarce perceptible.

EXPERIMENT XVIII.

Sp. sal.
ammon.
commun.

To eight ounces of the several waters were added sixty drops of common spirit of sal ammoniac. This caused a degree of cloud and precipitation, considerably greater than in Experiment XVII. but not so great as when *lixiv. tart.* was used.

EXPERIMENT XIX.

Lime-
water.

To eight ounces of the water of the King's hot and Cross Baths, fresh pumped, was added two ounces of lime water; a sudden flaky precipitation, of a blueish white tinge, happened in all, but was most copious in the water of the King's, and least so in that of the Cross Bath; the precipitated matter in all of them remained at the bottom, in form of snow, and not in a white powder, as in the Experiment with *lixivium tartari*. I repeated this Experiment with the same waters, which had stood loosely corked about half an hour, when the precipitation was much less than in the foregoing instance, but still greatest

greatest in the King's Bath water, and next PART III.
to that, in the Hot Bath water, and least
of all, in that of the Cross Bath.

EXPERIMENT XX.

To eight ounces of the King's Hot and Cross Bath waters, that had stood in bottles uncorked twenty-four hours, I added to each two ounces of lime-water; no change of appearance or precipitation took place.

N. B. No effervescence was observed, on addition of any of the above-mentioned substances to the Bath Waters. Probably what gave rise to the common opinion of their effervescing with alkalies was, that this Experiment was tried with those salts in their solid form, and the air bubbles formed in the solution, were mistaken for an effervescence.

EXPERIMENT XXI.

To each of the waters of the Baths, precipitated as in Experiments XIV. XV. XVI. XVII. XVIII. and XIX. was added five drops of spirit of nitre, which restored them all to their transparency.

PART III.

EXPERIMENT XXII.

Vitriolic
acid.

To eight ounces of the King's Hot and Cross Bath waters, were added twenty drops of spirit of vitriol, without the least precipitation, or sensible change in any of them.

Nitrous,
muriatic,
and ve-
getable.

N. B. This Experiment was repeated with the nitrous, muriatic, and vegetable acids, without producing any alteration in the water of any of the springs.

EXPERIMENT XXIII.

Solution
of silver.

To four ounces of the King's Hot and Cross Bath waters, was added six drops of solution of silver in the nitrous acid. A considerable cloudy precipitation, with some degree of a pink tinge, immediately took place in each, but the change of colour was rather more remarkable in the water of the Hot and Cross Baths, than in that of the King's Bath.

EXPERIMENT XXIV.

Solution
of lead.

To four ounces of the waters of the King's Hot and Cross Baths, were added six drops of solution of lead in the nitrous acid. A white cloudiness immediately took place, with

with a faint pink tinge, which last was likewise rather more remarkable in the water of the Hot and Cross Baths, than in the King's. PART III

EXPERIMENT XXV.

To four ounces of each of the waters was added six drops of the solution of mercury in the nitrous acid. A cloudiness immediately took place in each, of a light yellowish colour, but I could not discover in which it was most observable. Solution of mercury.

EXPERIMENT XXVI.

To four ounces of the waters of the several springs, I added ten drops of solution of copper in the nitrous acid; this gave a light blue tinge to each of them, with a slight flaky precipitation. Solution of copper.

N. B. The colour imparted to any of the waters in this Experiment, was not deeper than when the same quantity of the solution was added to four ounces of distilled water.

EXPERIMENT XXVII.

To eight ounces of the waters of the above-mentioned springs, were severally Solution of sugar of lead.

R 3

added

PART III. added a tea-spoonful of solution of sacch. saturni in water; a whitish cloudy precipitation appeared in each, but was rather more copious in the Cross Bath water.

EXPERIMENT XXVIII.

Solution
of corro-
sive sub-
limate.

To eight ounces of the water of the several Baths, were added to each twenty drops of a solution of corrosive sublimate in water. No change occurred in any for some time, but on standing, I could perceive a faint blueish white cloud, and a slight film on the surface of the waters of the King's and Hot Bath, and a slight degree of cloud in the water of the Cross Bath; a small yellowish precipitation took place in the Hot Bath and King's Bath, which was not observed in the Cross Bath Water.

EXPERIMENT XXIX.

Tincture
of galls.

To eight ounces of the several waters, I added thirty drops of tincture of galls, made with brandy. This occasioned in all of them a slight purple tinge, which was rather deeper in the water of the King's Bath than in the Hot and Cross Bath Waters, which seemed nearly of a similar tinge.

Ex-

E X P E R I M E N T X X X .

To a quart of distilled water I added PART III.
one drop of solution of green vitriol in water ; I then put in twenty drops of tincture of galls, drop by drop ; the purple colour produced was very faint at first, but on standing, increased ; and on adding a tea-spoonful of lime-water, grew much deeper than in the last Experiment.

N. B. The purple tinge caused by adding tincture of galls to the Bath Waters, was not increased in the least by the addition of lime-water.

E X P E R I M E N T X X X I .

Several slips of paper rubbed with the flowers of fresh violets were immersed in the waters of the several Baths ; the purple tinge seemed rather heightened by the water fresh drawn, but after standing, it seemed to change them rather to a greenish cast.

Vegetable
blues.

N. B. The King's Bath Water appeared to heighten the colour more than either of the others.

PART III.

EXPERIMENT XXXII.

Soap.

Two ounces of the waters of the several Baths were each of them agitated with half a drachm of castile soap; the several fluids appeared flaky and turbid, and on standing, a curdled oily substance floated on the top, and the water beneath became again clear.

N.B. The King's Bath Water seemed to make the most entire separation of the oily parts.

EXPERIMENT XXXIII.

Milk.

To two ounces of milk, boiling hot, was added four ounces of the King's Bath Water; a light curd was soon formed, but not an entire separation of the cheesy parts, as the whey retained some degree of a milky appearance.

N. B. This Experiment was tried with the waters of the Hot and Cross Baths, and in both of these some precipitation of a curdled substance was observed to take place; but the separation was not so compleat as when the King's Bath Water was used. The coagulation of the milk did
not

not take place when mixed with any of PART III.
the Waters that had stood open some time,
or been suffered to cool.

E X P E R I M E N T XXXIV.

A pitcher with a narrow neck, of a gallon and a half contents, was filled with the King's Bath Water from the pump, and a syphon immediately inserted into the neck of it, communicating with a bottle containing eight ounces of lime water. No turbidness appeared for some time, but a thin film was, after two hours standing, formed on the surface of the lime-water, and on longer standing a slight cloudiness was perceivable in the upper part near the surface, though the communication with the outward air was entirely prevented.

N. B. This Experiment did not succeed except made with the water fresh drawn. I tried the above Experiment with the Hot and Cross Bath Waters, with something of the same effect, though in a less degree.

E X P E R I M E N T XXXV.

Instead of the vapour arising from the Bath Water, I conveyed that which arose
from

PART III. from mixing lixivium tartari with the nitrous acid into a bottle containing a like quantity of lime-water; this caused an immediate cloudiness in the lime-water, and film on the surface, and in a short time a precipitation of all the lime in a flaky form.

EXPERIMENT XXXVI.

A drachm of steel filings was put into a bottle, and to it added six ounces of the King's Bath Water, and the whole shaken up. After standing a quarter of an hour, the water was poured off and filtered. On addition of twenty drops of tincture of galls, it struck a purple colour many shades deeper than when the trial was made with the simple Bath Water.

I tried the Experiment with the waters of the other two Baths with the same event, though in a less degree, and I found likewise that it succeeded in some degree with all the waters, even when grown cold.

EXPERIMENT XXXVII.

A piece of lean mutton, which was grown tender by keeping, was divided into four parts, each weighing one drachm, and
each

each of these were put into four ounces of the waters of the Hot, King's, and Cross Baths, filled from the pump, and immediately closed up, and the fourth into an equal quantity of distilled water, heated to a like degree, which was immediately closed likewise. After standing twelve hours, I took out the corks, and placed them in a room of the temperature of fifty-eight or sixty degrees of heat. In three days, that in the distilled water had acquired a degree of foetor, and emitted some bubbles, but the other three were perfectly sweet. On the fourth, that in the distilled water was very foetid, and that in the Cross Bath Water began to smell, and emit bubbles from it. On the fifth day, the piece of flesh in the distilled water was grown extremely foetid, and was become so tender as to be separated into small bits by a slight force. That in the Cross Bath Water had emitted many air-bubbles, and had an evident putrid foetor, yet the cohesion of its parts was not remarkably less than when fresh. The pieces in the Hot and King's Bath Waters had some air-bubbles adhering to them, and had some, though a very small degree of foetor. I then removed
them

PART III. them all into separate bottles, and washed three of them with the waters in which they had been at first immersed, by placing them under the pumps, and washed the fourth with distilled water of a like heat. The fœtor in those pieces which had been immersed in the Hot and King's Bath Waters was soon removed, but no great alteration was perceived in that of the Cross Bath, save a small abatement of the fœtor, owing to some of the most putrid particles being washed off; that in the distilled water lost all its cohesion on addition of the hot water, and fell to-pieces. The cohesion of those pieces which were immersed in the Hot and King's Bath Water was not remarkably altered.

EXPERIMENT XXXVIII.

I took a piece of lean mutton, weighing one ounce, which had acquired a slight degree of fœtor, and divided it into three pieces of equal weight, put each into an open bottle, and placed one under the King's, another under the Hot, and a third under the Cross Bath pumps. After pumping on them about three minutes, they were removed, and the fœtor in those that
were

were placed under the Hot and King's PART III, Bath was entirely gone off, and that under the Cross Bath nearly so likewise. I tried the above Experiment with hot water, but the fœtor, though abated, was not entirely removed.

EXPERIMENT XXXIX.

I took three pieces of lean mutton, that had acquired a considerable putrid fœtor, and placed them under the pumps, as in the foregoing Experiment, but the putrid smell could not be thereby corrected in quality, though less in degree, which last was probably owing only to the washing off some of the most putrid particles.

EXAMINATION *of the* SAND *found in the*
Cistern of the KING'S BATH.

Near the middle of the King's Bath, about four feet below the surface, is a large leaden reservoir, through which some of the principal springs flow, in their passage upwards into the Bath, and into which the pipe which supplies the pump is inserted. Once in three or four years (as I am informed) this is opened, in order to
clear

PART III. clear it of a sandy substance, which the water brings up and deposits there, and which, if suffered to accumulate, choaks up the end of the pipe which supplies the pump.

This sand is moderately fine, of a light grey colour, intermixed with a number of black particles, which, when examined through a microscope, appeared not to be crystalline substances, like great part of the remainder of the sand.

It is not more ponderous than common sand of the same fineness.

The Hot and Cross Baths have a reservoir of nearly the same construction, but I cannot find that it is ever necessary to open them on the same account, or that any substance of this kind was ever found in them.

*Chemical ANALYSIS of the SAND found in
the Cistern of the KING'S BATH.*

EXPERIMENT XL.

A drachm of the vitriolic acid diluted with four times its quantity of water was
added

added to half an ounce of the King's Bath sand; a sharp effervescence ensued, and many air bubbles were formed. PART III.

The like happened on addition of the nitrous, muriatic, and vegetable acids; with the last, however, in a very small degree.

EXPERIMENT XLI.

This sand sprinkled on a red hot iron gives a blue flame, and emits a highly acid vapour, in smell like that discharged from burning sulphur.

EXPERIMENT XLII.

About two drachms of the Bath sand were put into a crucible, with an equal weight of powdered charcoal. When the matter was thoroughly heated red hot, it was poured out, several particles of it were then vigorously attracted by the magnet.

To the taste the Bath sand is not in the least saline, but impresses, on being kept in the mouth some time, a strong chalybeate taste.

Ex-

PART III.

EXPERIMENT XLIII.

Two ounces of distilled water were infused on two drachms of Bath sand in a vial, which was kept in a moderate heat about an hour; the taste of the liquor was then highly chalybeate, but not obviously sulphureous. On addition of twelve drops of tincture of galls, little change was produced, except a slight purple tinge. By dropping in, however, four drops of lixivium tartari, the whole turned to a deep purple, nearly approaching to black.

This Experiment succeeded equally well when the Bath Water was used either fresh from the spring, or when grown cold.

EXPERIMENTS *on the* STONE *found near*
the City of BATH.

Among the hills surrounding this city are found divers quarries of stone, of different sorts, which are principally used in building. As this is found in vast quantities round the city, it was thought proper to examine some of the kinds, as it was very probable that the hot springs in their course might flow through several beds of this substance.

It

It is of several kinds, varying considerably in point of hardness, but the two most remarkable are that which is used for building the rough walls, and that which is used for casing buildings and making ornaments. They are both very soft as stones, but the former is much the harder of the two, though still soft enough to be worked with a stone axe. It is of a light brown colour, with a tinge more inclining to yellow. They both effervesce and dissolve in acids. The harder stone contains about one fifth part soluble in spirit of nitre, and the softer about one third. They harden on exposure to the air, and when got at a proper season, viz. the beginning of summer, in general stand the weather well, but when dug in the autumn, or winter months, are apt to crack by the frost, from their containing a great quantity of moisture when fresh dug, which is frozen in the stone before it can exhale.

EXPERIMENT XLIV.

I powdered about an ounce of the softest kind of Bath stone, and infused it in a pint of distilled water, and then filtered it. It

S

con-

PART III. contained a degree of wheyish tinge, from which I could not free it even by repeated filtrations. The filtred liquor had a taste evidently resembling lime-water, in that rough sensation with which it affects the roof of the mouth, though destitute of its empyreumatic flavour.

EXPERIMENT XLV.

An ounce of the same stone used in the foregoing Experiment, was powdered, and well rubbed in a mortar, with a drachm of flowers of sulphur. To this was gradually added, during the trituration, a pint of distilled water heated to one hundred and twenty degrees, or a little more, and then filtred. The filtred liquor was perfectly clear, but had a taste evidently sulphureous; and when warmed again to the same degree of heat, was judged, by several who tasted it, to resemble the Bath Waters very much, especially that of the Hot Bath.

I repeated this Experiment with the harder kind of stone, used for building rough walls, and found the same effect, though in a less degree.

EXPE-

EXPERIMENT XLVI.

I took an ounce of the soft stone powdered, and trituated it in a mortar, with half an ounce of the King's Bath sand, and gradually added, during the trituration, a pint of distilled water, heated to one hundred and twenty degrees, and then filtered it. The taste was evidently sulphureous, and when heated to the same degree, resembling the Bath Waters very much. PART III.

APPLICATION of the foregoing Ex-
PERIMENTS.

I shall now endeavour to apply these Experiments to the discovery of the impregnation of the Waters.

And here I shall take another view of the substances before mentioned, as possible impregnations of Mineral Waters, in the order they are there placed, and endeavour to shew of each what proof or probability there may be that it has or has not a share in the composition of the Bath Waters. The first of these that occurs is,

A C I D S.

* I. *The* VITRIOLIC ACID.

PART III. The existence of this substance in its separate state in the waters has been much disputed. Even their sensible qualities, with respect to this impregnation, have not been clearly ascertained.

I cannot say I have ever had an opportunity of observing its effects in so sensible a degree as mentioned by Dr. Lucas †, yet am inclined to pay some credit to it, as this acid is probably present in the waters united with iron, which it quits as soon as it communicates with the open air. This is rendered likely by Experiment XXIX. with tincture of galls, by the ochrous incrustations deposited round the surface and sides of the Baths, which were shewn to be reducible into iron, and by the sand itself of the King's Bath imparting a chalybeate quality to common water. Arguments, however, sufficiently plausible, are not wanting to contradict

* These marks, in this series, refer to the Table of Impregnations, p. 194.

† Vol. III. p. 227.

the existence of an unneutralized acid in these waters, even though it was granted that their vapour were so. PART III.

The Vitriolic Acid in these cases, it may be alledged, flies off, as it is disunited from the iron, and does not remain in the water in its separate state. The sensible qualities of the waters seem to favour this opinion. No acidity has been ever asserted by any person, whose writings I have examined, to be perceptible to the taste, and the trite experiment of syrup of violets being turned green by it, has been brought as a proof of a very different impregnation, and such a one as could not possibly subsist with the other. It has, however, been urged, that the Bath Water curdles milk, decomposes soap, and effervesces with alkaline salts, which are all properties belonging to acid bodies. That waters containing an acid would produce these effects is certainly true, but the two former of these are not qualities peculiar to acids only, but producible by means of other substances, and the last I cannot help believing a mistake. By Experiment XVI. it did not appear that any effervescence was produced on

PART III.

such admixture, although the lixivium tartari which was used is the mildest state of alkaline salts we know of, and of consequence most favourable to a discovery of this kind. Probably this mistake was produced by the cause mentioned in the foregoing Experiments.

The principal reasons that induce me to suspect that the Vitriolic Acid is present here, are, that the Bath Water heightens the colour of the vegetable purples, and gives a yellow precipitation with solution of mercury*. On the whole, then, if this acid be present here, which is very doubtful, it is in exceeding small quantity, and which probably, considered as such, can have very little power in influencing its effects as a mineral water, as it is likely that a quantity of it, not exceeding a drop of the concentrated Vitriolic Acid, is present in many pounds of the water. This is rendered farther probable, by the Experiment before cited of it, when combined with iron. This proportion being so small, perhaps may be the reason why they ex-

* Vide Experiment XXV.

hibit

hibit none, or no perceptible effervescence, PART III.
with alkaline bodies. The King's Bath
seems to give more marks of containing
this substance than either of the other two.

A L K A L I E S.

II. *The Fossil Alkali.*

Was the above opinion with respect to the last mentioned substance ascertained, we might be well assured that this had no share in the impregnation of the waters in its separate state; but as that is offered only as matter of conjecture, I shall examine the reasons which might support or contradict the opinion of the presence of this substance in these waters.

The only circumstance that gives us any reason to think that the Fossil Alkali enters into their composition, is, that the vegetable blues and purples seem to acquire a greenish cast, on being added to the water, which has stood some time. This, however, though a quality of alkalies, is by no means a certain test of that substance. Waters impregnated with calcareous earths, in form of quick lime, will produce this effect as well as alkalies, though not in-

PART III. deed so powerfully. No marks of this salt appeared in the residuum left on evaporation of any of them, and the precipitation of silver, lead, and mercury, from their solutions, was probably owing to another cause, which I shall mention hereafter. The iron contained in the water in a state of solution by an acid, the curdling of soap, and the coagulation of milk, likewise afford sufficient proof that this substance, in its native form, uncombined with any other body, has no share in the composition of these celebrated waters.

III. VOLATILE ALKALI.

The Experiment XXVI. with solution of copper, is an evident proof that the Volatile Alkali does not enter into the composition of the Bath Waters.

COMPOUND SALTS.

IV. GLAUBER'S SALT.

It does not appear by any Experiments, that there is any reason to think that this salt is contained in the Bath Waters. Some of the crystals left on evaporation were, indeed, of an hexagonal prismatic form, but

but were likewise of a slightly austere and astringent taste, and of very difficult solution in water, qualities that ill agree with Glauber's Salt. These circumstances afford sufficient evidence of what has been before laid down, as, if this salt had existed in the smallest quantity in the waters in a state of solution, it must have been thus discovered, as this salt is not so subject to decomposition, by long boiling, as many others are.

V. VITRIOLIC AMMONIAC.

There is not the least reason for believing the existence of this substance in the Bath Waters, since it would have, undoubtedly, manifested itself on addition of solution of copper, by the blue colour produced, which is always the case when the solution of that metal is added to waters, containing any saline substance that has the volatile alkali in its composition.

VI. COMMON SALT.

The existence of this substance in the Bath Waters has been pretty generally acknowledged, though its proportion there seems too small to have any share in their medicinal

PART III. medicinal effects. The cubical figure and peculiar taste of the crystals are a sufficient evidence of this, as no other saline substance, that we are acquainted with, takes that form on crystallization. To this likewise is owing the precipitation of lead and silver * from their solutions.

These, joined to the Experiments III, IV, and V. render the presence of this substance very certain, though it is but in a very small proportion, and probably but of little consequence in producing any of the effects usually attributed to the Bath Waters.

For the proportions contained in the several baths, *Vide* Experiments I. and II. Part III.

VII. SAL AMMONIAC.

This is proved not to be present in the Bath Waters, for the reason before given of Vitriolic Ammoniac.

* The Vitriolic Acid, and the salts containing it, precipitate the solutions of lead and silver. But the precipitation is not near so plentiful as when occasioned by common salt, and always assumes more or less of a yellow tinge, whereas this was of a milky whiteness.

INFLAM-

INFLAMMABLE BODIES.

VIII. FOSSILE OIL, *per se*.

The next class of bodies that offers it- PART III.
self to our view is that of Inflammables,
among which the Fossile Oil, in its separate
state, bears the first place. Of this, how-
ever, I have little more to say, than that the
Bath Waters do not give the least suspicion
of any impregnation of this kind, either by
their sensible qualities, or chemical analysis.
The taste and smell of this substance are,
indeed, in general, so potent, and so distin-
guishable, as to leave no room for a mistake
of this for any other impregnation. The
immiscibility of this oil with water likewise
affords an easy and obvious method of de-
tecting it, even though its quantity should
be too small, and its nature too pure, to
admit of a discovery, from its other sensible
qualities*.

* The Fossile Oils, when pure, in form of naphtha, are thin, nearly colourless, and transparent, and have none of that strong smell and flavour they so eminently possess in the form we get them. The two last qualities are probably owing to the admixture of some foreign body, which a great Chemist thinks to be the Vitriolic Acid.

As

PART III. As this oil, however, is not in the least degree soluble, and only diffusible in water, however minute this may be, it must separate on standing.

But no such circumstance has ever been observed in the Bath Waters, nor do their smell, taste, &c. favour any opinion of this kind. We may therefore safely conclude, that the Bath Waters do not contain this substance in the smallest degree.

IX. FOSSIL OIL *in form of* SOAP.

There does not seem to be any more reason for believing that this substance is contained in the water in its compound, than in its simple state. The taste and smell of it would be equally distinguishable in this, as in the last mentioned form. And if even (for the reasons above-mentioned) these might not be so observable, yet an addition of any acid substance would presently make the discovery, by the separation of the oil from the water it was united with. If the opinion, that the Bath Water contained Vitriolic Acid in substance, was confirmed, it would put an end to all doubts of this kind at once, but

as

as I offer that only as matter of some probability, I shall not lay any stress on it in point of argument. If the oil were thus combined with the water in form of soap, it must diminish its transparency, (since the oil is then only in a state of minute diffusion through the water.) But as none of these circumstances occur, we may rationally believe, that there are no more grounds for believing that oily substances are contained in the waters in this, than the last mentioned form.

X. SULPHUR *per se*.

I now come to the last impregnation of this kind, viz. Sulphur. This question has been much agitated by many able Writers, some of whom have maintained, and others denied, its existence there, with as much vehemence, as they would have done had every thing valuable belonging to them depended on this simple question.

I shall briefly examine the arguments that may be brought in favour of, or against, the opinion of the existence of this substance in the Bath Waters.

In confirmation of its existence, it has been said, that the sand and mud taken up
from

PART III. from the bottoms of the Baths, are evidently sulphureous from their smell; that the former, laid on a red hot iron, emits a blue flame and a suffocating vapour; that a solution of mercury is precipitated in yellow clouds by it, which is the colour it assumes when precipitated by sulphureous bodies; that corrosive sublimate is decomposed in the same manner; that a solution of silver in the nitrous acid is precipitated by them; that the mud of the waters, sublimed with arsenic in a retort, produced a true orpiment, and that the residuum left by the waters had the same effect.

On the other hand it has been alledged, that, granting the sand and mud taken from the bottom of the Baths contained sulphur in any proportion, yet that would not prove its existence in the waters, since we know sulphur to be insoluble in a watery menstruum, and that if it were united with the water by means of a subtile diffusion, that this would be soon discovered, by the precipitations happening on the waters standing, by the incrustations of the cisterns into which it first springs, and of the pipes through which it flows, as at Aix-la-Chapelle,

Chapelle, none of which circumstances are ever observed here. That the solutions of mercury and corrosive sublimate were changed to a yellow colour by the vitriolic acid, and that the bluish white clouds suddenly precipitating in grumes, on addition of the solution of silver, are owing to the common salt contained in the water. That the residuum, on evaporation, appears to be mostly a calcareous earth, and the remainder a saline substance, and that it gives no appearance of sulphur when laid on a red hot iron, only fuming and crackling slightly, without any sulphureous smell*, blue flame, sparkles, or detonation; that its effervescence with acids proved it not to be sulphureous, as that substance is not affected by them; that the taste of it shewed no signs of any contents of this nature, being only simply saline, and that but in a moderate degree; that the colour of bright polished silver was not tarnished or impaired by lying in the waters a considerable length of time†.

On a review of these arguments I am inclined to think, that the latter, on the

* Lucas, vol. iii. p. 312.

† Ib. p. 281.

whole,

PART III. whole, are tolerably conclusive as to this point, though they are far from being all of equal weight, or fairly stated. That which has been most relied on, viz. of the residuum left by the waters on evaporation yielding sulphur, is the least determinate of any, as the sulphur, if but in small proportion, would undoubtedly be dissipated in the evaporation, as sulphur is decomposed by long boiling and plentiful dilution with water. Nevertheless, as they have no taste of this kind, nor deposit any substance on standing that bears the least resemblance to it, and do not tarnish silver, or turn black with solution of sacch. saturni, we may safely conclude, that in this form it makes no part of the composition of the water.

XI. HEP. SULPH. *with an* ALKALI.

Sulphur, (as was before observed,) though not soluble in water *per se*, becomes so in a considerable degree, when combined with a caustic alkali, and even in some degree with a mild one.

As this combination is by no means infrequent in the bowels of the earth, and is indeed no uncommon impregnation of Mineral Waters, and as those of Bath undoubtedly

doubtedly meet with many substances in their passage that yield sulphur plentifully (as was taken notice of before,) many have imagined, it was united with them by some means of this kind. There seems, however, to be little foundation for such a supposition, as the taste and smell of this compound are so distinguishable, even in small quantities, as to leave little doubt concerning its nature when present. No such qualities have been ever observed in the Bath Waters. They are nearly inodorous, and their taste, though peculiar, by no means resemble those of that kind. Should it be urged, in answer, that the quantity contained in the waters is too small to affect their sensible qualities, (in which case it would be but of little effect,) we may reply, that, even granting it were so, chemical experiments by no means favour such an opinion. It appears by these, that silver is not tarnished in the smallest degree by lying in them, and the solution of sacch. saturni precipitated not in a dark coloured, but a yellow cloud. Acids likewise make no precipitation in them, which would undoubtedly be the case did the springs contain sulphur in this form, as we find by

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expe-

PART III. experiment of the Harrowage and other waters, that contain an hepar sulph. of this sort. We may therefore fairly conclude; that the Bath Waters do not contain sulphur in this form.

XII. HEPAR SULPH. *with* QUICK-LIME.

Calcareous earths, in their caustic state, on being mixed with sulphur, render it, in some degree, soluble in a watery menstruum, as well as alkaline salts, though not in so large a proportion. From the frequency of both these substances in the earth, we should expect this to be a common impregnation, and indeed I believe it to be much oftener present than it is suspected to be.

An eminent Writer on the Bath Waters has taken much pains to prove, that sulphur makes no part of their composition. His reasonings on this head seem well adapted to the subject, and prove very fully, that sulphur, in the two forms above-mentioned, has no share in it. That ingenious Gentleman seems to have failed only in making his position too general, to which he seems to have been induced by too great attachment

ment to theoretical reasoning, as it does not appear he made any direct experiments to prove this point. It is likely that he concluded, and not without great appearance of probability, that a water thus impregnated would exhibit the same appearances with other substances on experiment, (though perhaps in a less degree,) as one that had the true hepar sulph. in its composition. PART III.

The principal reasons that induced me to suspect the presence of sulphur in this form, were drawn from observing, that the Bath sand contained sulphur, and a calcareous earth, which have been before observed to form a compound soluble in water, and that the Bath stone joined to sulphur, and even to the Bath sand, imparted to water a sulphureous impregnation. Nevertheless, the accounts given of this substance, and its effects, by so eminent a person and so competent a judge as Dr. Lucas*, by no means corresponding with my Experiments on the Bath Waters, caused much doubt with me on this subject. However, as the Doctor had related

* Lucas on Mineral Waters, vol. iii. p. 278.

PART III. no Experiments made with sulphur in this form, it occurred to me, that he might have overlooked it, for the reasons above mentioned. This inclined me to make the following comparative Experiments with an artificial preparation of this kind, which turned out totally different from what the Doctor had asserted.

EXPERIMENT I.

Two drachms of flowers of sulphur washed, and a like quantity of quick-lime, were rubbed together in a glass mortar. To this compound was added, by degrees, during the trituration, sixteen ounces of distilled water. This was afterwards filtered, and appeared a transparent fluid *. Its taste was pretty strong and peculiar, though little resembling any of the common sulphureous preparations that I have seen, or the Harrowgate Waters.

On standing exposed to the air, it abated of its pellucidity, and deposited a whitish

* A tea spoonful of the above mixture diluted with two ounces of distilled water, with the addition of a few grains of common salt, formed a compound resembling the taste of the King's Bath Water, when grown cold.

sediment,

sediment, and this happened, in some degree, even when the air was excluded. The quantity taken up by the water seemed to diminish very little the bulk of the original compound.

EXPERIMENT II.

ALKALIES *caustic*.

To one ounce of the last mentioned preparation, joined to one ounce of distilled water, was added ten drops of lixivium saponar. This, on standing, produced a slight milky colour, with some small precipitation, as in the corresponding Experiment with the Bath Waters*.

EXPERIMENT III.

ALCAL. *mild*.

To one ounce of the aforesaid mixture, diluted as in the last Experiment, was added ten drops of lixivium tart. A sudden flaky and copious precipitation took place, precisely of the same colour as in the cor-

* On this addition, the diluted mixture became nearly of the taste of the Harrowgate Spa. N. B. The mixture had the same effect on soap and its solution in rectified spirits as the Bath Waters.

PART III. respondent Experiment with the Bath Waters, and which, on standing, fell to the bottom, and left the fluid above clear.

EXPERIMENT IV.

ALK. VOLAT. *caustic*.

To two ounces of the above mixture, diluted as before, was added forty drops of spirit sal. ammon. c. calce viva, which produced the smallest degree of a milky cast, and gave no precipitation on standing.

EXPERIMENT V.

ALK. VOLAT. *mild*.

To two ounces of the above mixture was added forty drops of spirit sal. ammon. commun. This caused a milky appearance, with a flaky precipitation, but not so considerable as in the Experiment with lixivium tartari.

EXPERIMENT VI.

CALCAREOUS EARTHS *deprived of their fixed* AIR.—LIME WATER.

To two ounces of the mixture diluted as aforesaid, was added half an ounce of lime-water, which produced not the least sensible alteration in the body of the fluid.

Ex-

EXPERIMENT VII.

SOLUTION of METALS *.—Of SILVER
in the NITROUS ACID.

To two ounces of the mixture diluted as PART III.
above, was added six drops of solution
of silver. This caused only a very slight
milkiness on standing, scarce perceptible.

EXPERIMENT VIII.

Of LEAD in the same.

To two ounces of the mixture was
added six drops of solution of lead. This
caused scarce any change, except a very
slight milkiness, even less than in the for-
mer Experiment.

EXPERIMENT IX.

SOLUTION of SACCH. SAT. in WATER.

To two ounces of the mixture as before
was added ten drops of the solution of
sacch. saturni. This caused a whitish
cloudy precipitation of a reddish tinge, as
in the Experiment with the Bath Waters.

* To one ounce of the distilled water used here, was
added six drops of solution of silver. This induced a slight
milkiness, as in Experiment VII. with the hepar sulph. c.
calce viva.

EXPERIMENTS *on* BATH WATERS.

EXPERIMENT X.

ACIDS.

SP. VITR. NITRI, &c. SALIS.

PART III.

To two ounces of the mixture as above, was added five drops of the vitriolic, nitrous, and muriatic acids, without causing the least effervescence, precipitation, or change of colour.

EXPERIMENT XI.

SOLUT. *of* CORR. SUBL. *in* WATER.

Ten drops of a saturated solution of corrosive sublimate were added to two ounces of the mixture as before. A blueish white cloud was immediately precipitated, and a thin film floated on the top, as in Experiment XXVIII. with the Bath Waters.

EXPERIMENT XII.

SOLUT. *of* MERCURY *in the* NITROUS ACID.

To one drachm of the original preparation, diluted with one ounce of distilled water, was added fifteen drops of solution of mercury in the nitrous acid. This caused a slight reddish white precipitation, which remained in the middle of the liquor, but did not subside.

E x-

EXPERIMENT XIII.

*With the RESIDUUM deposited on standing,
by the Solution of HEPAR SULPH.
with QUICK-LIME.*

Six grains of a whitish equable residuum PART III.
deposited by the solution of hep. sulph. c.
calce viva, on standing, were collected.
Two grains of this were laid on a red hot
iron, it fumed slightly, but gave no blue
flame, sparkles, or detonation, nor emitted
the least sulphureous smell, though care-
fully observed. The residuum, on burning,
changed from a white to a light ash colour.

N.B. This Experiment was several
times repeated.

EXPERIMENT XIV.

Ten grains of the above residuum were
collected and carefully dried with a very
gentle heat. To this were added five
drops of the vitriolic, nitrous, and muriatic
acids. It effervesced strongly with each
of these, and with the vitriolic formed a
saline substance, which appeared, from its
taste, &c. to be selenites.

Ex-

E X P E R I M E N T X V .

VEGETABLE BLUES, *with the* SOLUT. *of*
HEP. SULPH. *with* QUICK-LIME.

PART III.

A piece of writing paper stained with the blue leaves of violets, and another with the purple of polyanthus flowers, was immersed in a quantity of the mixture diluted as above, and fresh made. No change of colour happened. The same Experiment was tried with it after having stood exposed to the air some time, when it immediately changed them to a green colour.

E X P E R I M E N T X V I .

Two ounces of the mixture were added to an equal quantity of the Bath Water without any observable change.

From a review of the above Experiments, it appears that most of them correspond in effect with those made with the Bath Water; and in those where the appearances differ, I think the variation is owing to some other substances, which are known to form the impregnation of the Bath Waters, besides the foregoing. In order to evince this the more clearly, I propose

pose to give a short comparative view of PART III.
the effects produced by the same Experiments on the Bath Water and the artificial preparation, and then see if these different appearances may not be explained on the foregoing principles.

REMARKS *on the* COMPARATIVE EXPERIMENTS.

CAUSTIC ALKALI.

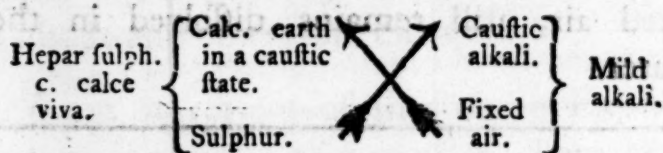
The effect of this seems nearly the same in both*. The caustic alk. seems to act in each, by decomposing the hep. sulph. c. calce viva, disengaging the lime from the sulph. and taking its place; which, however, as the caustic alk. supplies no fixed air, still remains dissolved in the water.

* Some small precipitation happened in the artificial preparation, as well as in the Bath Water, probably owing to the alkali not being perfectly caustic, which is difficult to procure. The Bath Water exhibited a much larger precipitation when fresh, than after having stood some time, which proceeded probably from the quick-lime disengaged by the alkali from the sulphur attracting the fixed air suddenly, which we have before seen so plentifully contained in the water when fresh drawn, and being thus precipitated. This accounts for this circumstance not being so observable in the water that had stood some time.

FIXED

FIXED ALKALI *mild*.

PART III. The hepar. sulph. is here decomposed, as in the foregoing Experiment, though the mild alkali is but very sparingly miscible with sulphur. A double decomposition, however, here takes place, which seems to effect their union. The quick lime attracts the fixed air from the mild alk. which is thus rendered caustic, and enabled to unite with the sulphur, while the lime thus rendered mild, and of course insoluble in water, falls down in form of a mild calcareous earth, and forms the copious white precipitation observed in the Experiment. This, however, will be better understood by the annexed scheme.

VOL. ALK. *caustic*.

The appearances shewn on addition of this substance, seem to be the same in both*.

* It is doubtful here if the hep. sulph. c. calce viva would be decomposed, as the quick-lime seems to have a stronger attraction to sulphur than the vol. alk. Probably the flight

VOL. ALKALI *mild*.

* The earth is here precipitated in both, PART III.
for the reasons given above, when I spoke
of the fixed alkali, but not in so large pro-
portion, as the vol. alk. is scarce ever got
so mild as the fixed, and besides does not
contain fixed air in so large proportion.

LIME WATER.

The effects of this on the mixt and on
the Bath Water when fresh, are totally diffe-
rent. With the former no perceivable effect
was produced; whereas, with the latter, it
occasioned a copious precipitation. This dif-
ference, however, may be easily explained.
The Bath Waters, when fresh, are known
to contain fixed air in a large quantity,
which the quick-lime in the water greedily
attracts, and is thus rendered insoluble, and,
of course, precipitated. Probably the form

slight precipitation (observed on standing) in both was ow-
ing to the alk. not being perfectly caustic, which is very
difficult, and, indeed, nearly impossible to procure, as it
attracts fixed air from even a silver vessel in which the evapo-
ration is performed when wanted in a dry form.

* The hep. sulph. c. calce viva seems to be here decom-
posed by a double elective attraction, which may be under-
stood by the scheme laid down in the foregoing page, only
substituting the volatile in place of the fixed alkali.

of

PART III. of the precipitation, when an alk. and lime-water were used, is owing to this, that in the former the lime was separated from the sulphur, in the latter only precipitated from its simple solution in water.

What proves this more clearly is, that the precipitation is the largest when the lime-water is added to the Bath Water fresh drawn, and is scarce perceivable when added to the water that has stood some hours exposed to the air *.

SOLUTIONS of SILVER and LEAD.

The event of the corresponding Experiments with these substances, turned out totally different, the solutions causing a large

* It might be here alledged, that the precipitation was owing to the volatile vitriolic acid, which (as was before said) there was reason to believe the presence of in the water's forming a kind of selenites with the lime, which, as being so sparingly soluble, would cause a precipitation. That this would equally account for the ceasing of this effect on the water's standing exposed to the air, as the volatile vitriolic acid soon evaporates. This, however, cannot be the case altogether, as the precipitate effervesced strongly with even the vegetable acids. As, however, there is reason to suspect the presence of the volatile vitriolic acid, the precipitate might be composed of both these substances, viz. a small part selenites, and the remainder a mild calcareous earth.

white

white precipitation with the Bath Water, whilst they shewed scarce any effect on the other; and the small degree of precipitation that was observed, was, in all probability, owing to some saline substance, perhaps the vitriolic acid, which it is difficult to get even distilled water free from. Thus much, however, we may reasonably presume, that the hepar sulph. c. calce viva is not the substance that causes this effect. What produces that plentiful precipitation in the Bath Water, is undoubtedly the common salt, which, as was before observed in the smallest proportion possible, viz. of one grain to a gallon of water, will cause a milkiness and precipitation with the solution of silver or lead. PART III.

SOLUTION of MERCURY.

The difference of the effects produced on addition of this substance to the mixt and to the Bath Water, is very observable. With the former it exhibited a slight reddish cloud, with the latter a copious white precipitation. This, however, seems owing to the same cause as the foregoing. In the former, the solution of mercury seems precipitated by the vitriolic acid, which is separated

PART III. separated from the sulphur by the attraction of the mercury, or by the decomposition of the hepar sulph. c. calce viva, in some degree, by its solution in water, which causes the precipitate to be of that reddish yellow colour, which is the same that mercury, precipitated by the vitriolic acid, always assumes. In the latter case, the precipitation is certainly occasioned by the common salt, the muriatic acid in it having a stronger affinity with mercury than the vitriolic acid has, which causes the difference of colour in the precipitations. What confirms this is, that if a few grains of common salt be previously added to the mixt, the mercury is precipitated from the solution of a white colour.

SOL. of CORROSIVE SUBLIMATE.

The appearances in both cases, on addition of this substance, seem nearly the same, and probably would have been exactly so, could we have brought the mixt to the exact standard of proportion of impregnation with the Bath Waters.

ACIDS

ACIDS, VITRIOLIC, NITROUS, *and*
MURIATIC.

The acids seem to have had no visible PART III.
effect on either the mixt or Bath Waters.
The mixt, when fresh, seems to agree with
the Bath Water, in its shewing little change
at first in the colour of the vegetable blues,
though when kept some time it exhibited
the same effect. The Bath Water, indeed,
when fresh drawn, seemed to change the
vegetable blues to a little of a reddish cast;
but this was probably owing to a superfluous
quantity of the volatile vitriolic acid, which,
as was before observed, there is some rea-
son to suspect the presence of in these
waters.

From what has been before urged, and
from the above comparison of the Experi-
ments, I think there is the greatest reason
to believe, that sulphur, in this form, makes
a part in the impregnation of the Bath
Waters. I own, that all the comparative
Experiments do not coincide, but those
which differ I hope have been satisfactorily
explained to proceed from the effect of
some other substance, whose presence there
we are assured of. The composition of
U the

PART III. the substance thrown up by the waters, called Bath sand, being demonstrated to be sulphur joined to a calcareous earth, proves the possibility of such an impregnation, and the agreement of the comparative Experiments made with an artificial composition of this kind, with those made on the Bath Waters in all the material circumstances, give, in my opinion, a rational proof of the existence of this impregnation.

The proportion in each of the Baths cannot easily be ascertained; I am inclined to think, that it is most prevalent in the Hot Bath, next in the King's, and least in the Cross Bath.

The next class of bodies that comes under consideration, is that of metallic substances. The first of which, in the order they are placed in the table, is,

XIII. C O P P E R.

There does not seem to be the least reason to suspect the presence of Copper in the Bath Waters. Iron immersed in them is, indeed, soon corroded, but no precipitation resembling copper is ever deposited on its surface, as is the case with all waters that contain

contain that metal in a state of solution. PART III.

The Bath Waters seem, indeed, to have very little effect on copper, as we see by the rings in the King's Bath for the bathers to hold by, which are mostly made of copper, and many of them, as appears by their dates, have continued near a century, and some of them longer, and still remain little diminished; whilst those of iron are entirely consumed in a twentieth part of the time. The caustic volatile alkali likewise shews no signs of a cupreous impregnation, but mixes with the water without any change of colour. No signs of this metal, in any form, appeared in the residuum left on evaporating the waters. The crystals there, were all colourless, and in taste and effects by no means resembled the blue vitriol. On the whole, we may rationally conclude, that this metal is not contained, in any form, in the Bath Waters.

XIV. I R O N.

The presence of Iron in the Bath Waters is universally acknowledged. The purple tinge they strike with solution of galls when fresh drawn, the ochrous incrusta-

U 2

tions

PART III.

tions formed round the edges of the Baths, which were shewed, by Experiment XIII, to be reducible into iron; the Experiments made with the residuum of the waters left on evaporation, and with the Bath sand, put this circumstance beyond a doubt.

As to the form in which it is contained, it appears to me to be dissolved in the water by means of the volatile vitriolic acid. My reasons are as follow :

Were it dissolved by means of the fixt vitriolic acid, the impregnation would be more permanent.

Hepar sulphuris with an alkali does not exist in the Bath Waters, consequently the chalybeate impregnation cannot be of that kind.

Were it by means of the hepar sulphuris with quick-lime, it would be likewise more permanent. It may, indeed, be asked, why the Bath Waters should lose their chalybeate impregnation so soon, since they retain, even when grown cold, or after exposure to the air for some time, a power of extracting a chalybeate tincture from iron filings? The cause I apprehend to be this.

That

That the metal is dissolved by the vitriolic acid in its volatile state, and on its flying off, falls down in form of calces not soluble in the water, by means of the sulphureous menstruum. It has been before observed, that the calces of metals are very difficult of solution. I am also inclined to think it not to be by means of fixt air, since an impregnation of the same kind, equally fugitive, may be imparted to distilled water, by means of the Bath sand.

As to the proportion of this metal contained in the Bath Waters, it is undoubtedly very small. Dr. Lucas has computed it at one thirty-seventh and a half of a grain of iron in a pint of the King's Bath Water, and this computation seems tolerably just. This circumstance, however, as he very properly observes, is very difficult to be ascertained with any great degree of exactness. The proportion of chalybeate in the other two Baths seems to be somewhat less, but in what degree I am not able to discover.

A curious question arises on the subject of this impregnation, which I have not seen taken notice of by any other Writers,

PART III. and which I own myself not able to resolve satisfactorily, viz. why these waters do not give stronger proofs of a chalybeate impregnation than they do? It does not appear, on their analysis, that they contain any substance that would precipitate the iron, were it contained in them in much larger quantities than it really is. And I find, in confirmation of the above opinion, that Bath Water, poured on filings of iron, dissolves them plentifully; and it appears by the above Experiments, that even cold water extracted in a few minutes so strong a chalybeate impregnation from the Bath sand, as to strike a deep black with solution of galls. Nevertheless, the Bath Waters, which, undoubtedly, pass through many beds of minerals, containing this metal in large quantity*, and that too in a form capable of solution in water, exhibit but a very faint impregnation of this kind. This circumstance seems difficult to account for. Perhaps it may be owing to the large proportion to, and swift passage of the water over the pyrites containing

* Both these circumstances may be reasonably presumed from the Experiments related with the Bath sand.

this metal. This, however, is not fully satisfactory, as it would hold equally strong against all the other impregnations, some of which are contained in the waters in much greater proportion than the chalybeate one. I will venture, however, to suggest a circumstance, which, though not of itself quite satisfactory, may yet throw some light on this subject. The learned Dr. Lewis gives an account of an Experiment, that has been related in the former part of this work, in which he found, that on addition of a fixed alkaline salt to a solution of green vitriol, no decomposition ensued while the air was excluded, but that on its admission, the acid and alkali presently united. May not the volatile vitriolic acid, in like manner, exert but little effect on the ferruginous particles until the communication with the air is obtained, and then its swift passage may not afford opportunity for a more plentiful impregnation*?

* It may be alledged, that this argument might be urged with equal force against all chalybeates whatever. These, however, may some of them have access to the air by some subterraneous passages, or caverns, similar to those mentioned in the account of the vitriolic acid *per se*, and its separation by decomposition from the pyrites, which may not be the case with the Bath Waters.

PART III.

If this theory should be blamed as too vague or uncertain, I beg leave to repeat the excuse I have formerly made, which is, that I offer these things only as matters of conjecture, and this, I hope, will plead in behalf of mentioning them.

On the whole, then, the presence of this metal in the waters is beyond a doubt, though its proportion there seems to be smaller than in any chalybeate I have examined.

XIX. Z I N C.

The presence of this mineral has never been suspected here. Indeed (as has been before observed) it is a doubt if ever it forms a native impregnation of springs. However this may be, there does not seem to be the least reason for thinking it makes any part of the composition of the Bath Waters. Its sensible qualities, and the effects it produces, even in very minute quantities, when dissolved by the vitriolic acid, which is the form it must exist in, if at all, by no means coincide with those usually produced by these celebrated waters. Zinc, thus dissolved, is possessed of emetic, and, at the same time, narcotic qualities,
and

and these effects are produced by a very small proportion of it. These qualities, however, ill agree with those of the Bath Waters, and the cure of those disorders, for which they are so much famed. PART III.

The crystals likewise procured on evaporation of the Bath Water have nothing of the sweetish taste, so remarkable in the white vitriol, and are likewise of more difficult solution in water. In a word, we have not the least reason, either from the sensible qualities, or chemical analysis of them, to suspect that Zinc enters into their composition.

In the former part of this Work, I mentioned the three impregnations, above spoken of, as being all of the metallic kind, that were to be found native in Mineral Waters. Notwithstanding, however, this assertion, which I believe to be just as to native impregnations, an accidental combination with another metallic substance, and that too not the most innocent with respect to the human body, may sometimes take place in them, especially in those of the thermal kind.

LEAD.

L E A D.

PART III.

The effects of Lead on the human body are well known. "Obstinate constipations, violent colics, pains and contractions of the limbs, tremors and resolutions of the nerves, and slow wasting fevers, are the consequences of this metal taken internally, and of the fumes to which the workmen are exposed* in the fusion of this metal in the way of business;" and even the external application of cerusse has been known to produce this effect. This metal, however, is generally thought not to be soluble in the vitriolic acid, unless in a boiling heat; and this seems true with regard to the fixed; but as to the volatile, it is by no means to be depended on, as that will act on Lead in an inferior degree of heat; and though its attraction to metals does not seem to be so strong, yet it dissolves them in much larger proportion than the other.

After having given the above account of the effects of this pernicious metal, I should be sorry to insinuate any suspicion of its

* Lewis's Mat. Med. Art. Plumbum.

presence in these salutary springs. Nevertheless, the cistern which serves as a reservoir for the spring, at its first rise, appears plentifully corroded on its inside, by the long furrows which are visible in every part of it. This proves the possibility of such an impregnation, though probably its proportion there is too small, or perhaps counteracted by some other qualities of the waters, to work any obvious effects on the human body. But this is by no means a justification of the use of any thing liable to give an impregnation of this sort, in the slightest degree. A portion of several metallic substances, almost too minute to be discerned, is capable of working great changes in the human frame; and, among these, Lead claims the chief place, and is, perhaps, the most dangerous, as it frequently works by slow, and almost imperceptible degrees, and has often completed the mischief, before the person was sensible of his danger, or to what cause to attribute his malady*. The noted colic at

* Nec minus infelices qui aquam plumbo divitem bibunt. Plumbeis ædes testæ laminis, ubi pluvialis sola bibitur, in cisternis collecta, vel in plumbeis servata vasis, quod pessimum, frequentiore multò faciunt morbum: et hæc est ratio quare insolitus olim colicus dolor, grassetur nunc Amstelodami. Tegulis

PART III. Amsterdam was of this kind, which, for a long time, eluded the search of the learned with respect to its cause; and it seems probable, from some ingenious experiments by Dr. Baker, and others, that the Devonshire Colic proceeds from the same origin. If to this it should be objected, that we have no accounts of any such effects produced by the Bath Waters, and that, on the contrary, they have been proved to be very efficacious in the cure of these very diseases, we may reply, that the action of the water on this metal has been sufficiently proved, and that it is possible that the unfavourable symptoms sometimes produced on drinking them, which we know not how to account for otherwise, may be produced by some such impregnation; as this metal, though its

Tegulis antea tectæ, hodie plumbo teguntur ædes, supernè olim declives, nunc planæ. Volitantia sub finem autumnii folia decidua, viridarium enim crederetis urbem, ventis in tectæ feruntur, macerata ibi aquâ stagnante, hanc inficiunt acore, quo solum plumbum in cerussam abit, ad cisternam dein rapitur imbre, sic sensim inficitur aqua. Nec mirum si in aliis locis ubi deficit plumbum, arborea que defunt, minùs frequentes sint colici dolores. Hinc intelligitur quare si cadentibus foliis tenues nullæve sint auræ, si cautè ligno tegatur plumbum, salubrior aqua sit. Fidem observata merentur, vidi malum in integras sæviisse familias. Undecim in unâ domo uno tempore decumbentes, horrendis cruciatibus convulsi, membris soluti, mutato tecto, renovatâ aquâ, convaluerunt.—TRONCHIN, de Calica Pictorum, Art. 10, p. 66, 67.

effects

effects are sometimes latent, is seldom inactive. It may be, perhaps, owing to this cause, that some disorders of the spasmodic kind, as the Opisthotonus, seem sometimes rather enhanced by drinking the Waters, when bathing alone is of great service. This may likewise occasion the retardation, and sometimes the failure of cure, of many bowel disorders; and the obstinate costiveness * so much complained of on drinking the Bath Waters, which is a constant effect of that mineral, makes this conjecture not improbable. Effects, when slowly produced, and the reasons not self evident, are often neglected, or attributed to unavoidable causes, or circumstances to which they do not belong. The noted Colic at Amsterdam had many causes assigned for it before the true one was discovered, and it is possible that this quality in the Bath Waters may not be originally inherent in them, but perhaps owing to some accidental circumstance of this nature.

From an examination of their contents, I can discover nothing to which this effect

* The waters of the Hot Bath are observed rather to open than bind the body. The reservoir there is made of stone.

can

PART III. can rationally be ascribed; and if we reason from analogy, all the sulphureous preparations tend rather to loosen than bind the body.

An eminent and ingenious Writer has cautioned against the use of Lead in our common pumps; as he says, that although Lead may not be obviously soluble in common water, that a portion of it may be abraded, and so minutely comminuted * by the working of the pump, as to be suspended in water, and thus capable of being received into the human body. If this caution was well founded, as to laying aside the use of Lead in common pumps, how much stronger will it be applicable in this instance, where the pump is worked daily many hours together, and the abrasion consequent on it, proportionably greater, and the very water drawn by it, capable of corroding, if not holding it in a state of solution?

* There is great reason to think that this circumstance would increase the solubility of lead very much. Common flint glass, as we generally see it, is insoluble in any menstruum, yet, when finely ground down, is soluble in part in acids, and imparts to them a leaden impregnation.

If it be farther alledged, that no Lead PART III. appears to be found in the waters * by experiment, it may be answered, that this metal is sufficiently proved to be acted on, by the effect before-mentioned to be produced on the reservoir; and though the proportion contained in any quantity of water capable of coming under our examination, might elude a discovery by a chemical analysis, yet its effects on the human body might possibly be still exerted. This was the case at Amsterdam before quoted, where, though the disorder was undoubtedly owing to this cause, and its proportion vastly larger than it could be in this instance, it was still so minute as to be scarce discoverable by a chemical examination.

On the whole, when we consider the nature of those diseases which are generally recommended to these waters for relief, which are † many of them of the

* It is not improbable, that the decomposition of the tinctura sulph. volat. mentioned by Dr. Lucas, which I find, on repetition of the same Experiment, to be true, may be owing to some degree of an impregnation of this kind.

† Many minute circumstances, which perhaps might have scarce any perceptible effect on a person in health, might be of the worst consequence to those who are already predisposed to disorders of this kind.

same

PART III.

same kind with those occasioned by this pernicious mineral, and not a few actually produced by it, we shall then see the peculiar propriety of avoiding any possibility of an impregnation of this nature. I would therefore humbly, though earnestly, recommend to those, who are the guardians of these antient and justly celebrated fountains, to substitute a reservoir of marble, or, what perhaps may be full as proper, of grit stone, in place of the leaden one now used, and wooden, or, what may serve the purpose still better, cast iron pipes for the supply of the pumps*.

EARTHY SUBSTANCES.—SIMPLE.

XX. CALCAREOUS EARTH.

I mentioned, in the former part of this Work, that there was but one kind of earth that was ever found, in its simple state, native in springs, in sufficient quantity to bring them under the definition of

* I have the satisfaction of finding this piece of advice approved of by several of the most eminent of the Faculty, among whom I am happy in mentioning Dr. Dealtre, of York, Dr. Wall, of Worcester, Dr. Cuming, of Dorchester, Dr. Percival, of Manchester, and Dr. Haygarth, of Chester.

Mineral Waters, and this is the Calcareous. PART III.

Whether this enters into the composition of the Bath Waters, in its caustic state, and uncombined with any other substance, is a curious question. The copious precipitation of a calcareous earth, consequent on the addition of a mild alkaline salt, would lead us to imagine this to be the case, as this always happens on its being added to lime water.

If so would be precipitated by fixed air containing in it water which is well known to have a greater affinity to that earth than to any other substance

Though I do not deny that a small proportion of calcareous earth, in form of lime, may be found in the Bath Water that has stood some time, which is rendered still more likely by the greenish tinge the water gives to the vegetable blues in these circumstances; yet we have no reason to think any such substance is united to them when fresh, as they then seem to give proofs rather of an acid impregnation*. The signs they seem to give of an impregnation of an alk. nature, may be owing to the decomposition of the hep. sulph. c. calce viva contained in the Water, caused by the flying off of

* Vide Experiment XXXI. where it is said to change the vegetable blues to a reddish tinge.

PART III. part of the acid, and leaving a superfluous quantity of the calcareous earth, in form of quick lime, united with the water. By the above Experiments it appears, that the hep. sulph. c. calce viva answered all the tests above mentioned, which are commonly accounted proofs of the presence of a calcareous earth. The manner that this comes to pass has been above explained, when I treated of that substance*. Nor is there more reason to think that calcareous earth is contained in the Bath Waters, by being united with an over proportion of fixible air, according to Mr. Cavendish's theory, since, if this were the case, it must deposit the earth immediately on the evaporation of the fixible air, which is not the case.

* The calcareous earth, left on evaporation of the Bath Waters, might countenance the opinion of its presence there in a separate state. This however may happen, and is probably occasioned by the decomposition of the hep. sulph. c. calce viva, which, on standing exposed to the air, and more especially by strong boiling, suffers a decomposition, and of consequence separation of its parts; the vol. vitr. acid and phlogiston being dissipated, and the calcareous earth precipitated in a mild state. Selenites too, which is largely contained in these waters, undergoes, in the same circumstances, a similar decomposition, and may in part occasion this appearance.

The precipitation which occurs on the addition of lime water, is probably owing to the calcareous earth, precipitated from the lime water itself, by the fixed air in the Bath Waters, and never originally contained in the waters themselves. This is farther proved, by no precipitation happening in the waters, on addition of lime water, after they have stood some time, even though no spontaneous earthy precipitation has taken place.

We may then safely conclude, that Calcareous Earth is not found native and uncombined with any other substance in the Bath Water.

XX. EARTHY SUBSTANCES.—COMPOUND SELENITES.

Though I cannot allow that Calcareous Earths *per se* have any share in the composition of these waters, I own that, in their compound state, they form one of its principal impregnations. Combined with acid, in form of Selenites, they are undoubtedly contained in the waters, as appears plainly from the crystals left on

PART III. evaporation, which were of * an hexagonal prismatic form, of small size, nearly insipid, and scarce perceptibly soluble in water. To this impregnation the curdling of soap may possibly be owing, though that may be produced by the *hepar sulph. cum calce viva* †.

On the whole, the foregoing Experiments sufficiently prove the presence of this substance, though it does not seem to have any great effect in composing the medicinal qualities of the waters.

XXIII. SAL CATHARTICUS AMARUS.

The next body that comes under consideration, is the Spurious Glauber's Salt, or

* Selenites is described by many authors^a, who have wrote on the Crystals of Salts, as crystallizing on the surface of its menstruum in these laminæ. This, however, is only a mistake, since it only happens when the evaporation is carried so far as to form a pellicle on the surface. In that case it crystallizes in a seemingly laminated form. But, on microscopical examination, even these appear to be composed of hexagonal prismatic crystals, though small and irregularly formed, occasioned by their running into clusters, by too hasty a crystallization. By a judicious management of the heat, and sometimes by addition of a small quantity of rectified spirit, towards the end of the evaporation, selenites may be brought to form, in fair and well shaped crystals, at the bottom of the vessel.

† Vide note on Experiment II.

^a Lewis's New Dispensatory, p. 461. edit. 2.

Sal cath. amar. There does not how- PART III.
ever seem to be the least reason to authorize our belief of its presence in the Bath Waters. Their taste by no means resembles those of this kind, and the residuum left on evaporation gives not the least sign of it. Were this salt contained in the waters, it might be easily detected by this means, as the vitriolic acid is not separated from magnesia by the heat necessary for the evaporation, and then the hexagonal prismatic form, bitter saline taste, large size, and easy solubility of its crystals, would soon distinguish it from all others of this kind. The crystals, indeed, which appear, on the evaporation of the Bath Waters, are of the same form with those of the magnesia, Glauber's salt, and in some degree of a saline bitter taste, as all salts that have vitriolic acid in their composition are, but that is extremely slight in comparison with the other. They are likewise of small size, and not soluble, unless in a very large proportion of water, which sufficiently distinguishes them from those of the Sal cath. amar. which is soluble in as small proportion of water as

PART III. any saline substances we are acquainted with.

XXIV. A L U M.

The next substance that presents itself to my enquiries is Alum. The Bath Water, when nearly evaporated, has some degree of an austere bitter taste, but does not possess that nauseous sweetish one which is always inherent in Alum. A solution of a fixed alkaline salt causes, indeed, a white precipitation, but by no means in the flocculous form in which the earth of Alum is always precipitated, nor is any part of the precipitate re-dissolved, which is always the case when the fixed alkali is not added in sufficient proportion to saturate the superabundant acid contained in the Alum. Add to this, that the earth of Alum is equally precipitated by caustic as mild alkalies, which is not the case with the Bath Waters.

On examination, likewise, of the residuum of the Bath Waters, no marks of Alum are to be found; the saline particles are all hexagonal, or cubical, and of small size; whereas Alum, as was before observed, shoots into large angular masses, consisting
of

of eleven planes, five of which are hexagonal, and six quadrangular. Alum likewise is much more soluble in water than salt thus obtained, the former requiring only about ten times its weight of water to dissolve in, but the latter infinitely more. On the whole, we have no reason to think Alum to be an ingredient in their composition.

PART III.

AERIAL BODIES.

I now come to the last head of impregnations, viz. Aerial Bodies; of these the first mentioned in the Catalogue is Common Air,

XXVI. COMMON AIR.

This seems to be very sparingly contained in the Bath Water when fresh *, as fewer bubbles are observed in it, when placed under the exhausted receiver †, than in water that has stood some time exposed

* This Experiment was tried with the water taken up from the Bath. When the water from the pump was used the event was different.

† Though the Bath Waters fresh from the Spring shew but little marks of their containing Air by the Experiment mentioned above, yet, when grown cold, and having been exposed some time to the air, it exhibits the same appearances with common water.

PART III. to the atmosphere. This observation may, indeed, be applied to many springs, as they are all found to contain it in less quantity when fresh, than after remaining some time in an open vessel. The air likewise contained in these waters must be highly rarefied by their heat, insomuch as to be dissipated nearly on their first communication with the atmosphere, before it could be possible to make them the subjects of experiment. Thus we see common water, that has been boiled, or strongly heated in an open vessel, gives, for some time after, very little marks of containing air, exhibiting few or no air bubbles under the exhausted receiver, and freezing without any increase of bulk.

I am inclined to believe, that a considerable quantity of Common Air is united with the Bath Waters mechanically in their fall from the pipe, and that to this is owing, in some degree, the number of air bubbles, which we see adhering to the sides of the glasses when just filled. I have myself observed, in confirmation of this, that these were not near so numerous when the water was taken up, by immersing

ing a glass into the spring head, in the PART III.
manner as at Tunbridge, although the taste
was at least equally poignant, and all the
other sensible qualities equally remarka-
ble. Although this substance can hardly
be said to enter into their composition at
their first rise, yet, as it is always united
with them in the state in which they are
offered to us, and as its presence there is
probably by no means unimportant, I can-
not refuse it a place in the catalogue of
Impregnations.

XXVII. FIXIBLE AIR.

Although Common Air seems to be con-
tained in the Bath Waters but in small
proportion, this is by no means the case
with the Fixed or Mephitic Air, whose
presence here is very evident, and is pro-
bably one of the greatest sources of
their admired qualities. The sparkling
appearance, pungent taste, and, on many,
if taken in large quantity, inebriating
effects, are sufficient evidences of this. Per-
haps, likewise, the odour, mentioned by
Dr. Lucas as prejudicial to weak lungs, and
of

PART III. of an * acid pungency, might be more owing to this than to the volatile vitriolic acid, to which it is usually attributed. These indeed may be very easily mistaken for one another, as it is not improbable that an acid is always either united with, or makes part of, the composition of Fixed Air; since even that, when accumulated in large quantity, as on the surface of fermenting liquors, is found to change the colour of vegetable blues to red.

Chemical Experiments likewise confirm our opinion of this impregnation, which their sensible qualities had indicated. The precipitation of the lime from lime water, on admixture of the Bath Water, when fresh, and the ceasing of this effect, on its standing exposed to the air, the film produced on the same by the steam of fresh drawn Bath Water, conveyed by a bended tube on its surface, prove this very clearly. To this likewise is owing the bursting of the bottles, if corked up as soon as filled

* Dr. Percival found, that the air produced from an effervescent mixture of earths, or alkaline salts, with the vitriolic acid, was in some degree offensive to respiration, which was not the case when the vegetable acid was used.

from

from the spring, and in some degree the PART III.
sensible diminution of the bulk of the water, on standing a few minutes exposed to the air. To this, however, it may possibly be objected, that if the Bath Water contained Fixed Air in large quantity, its effects on the human body, so far from being salutary, must be highly prejudicial, since that substance is known to cause deleterious and even fatal effects; witness the many accidents that have happened from too near an approach to a vessel of fermenting liquor, whose effluvia, which we know to be composed principally, if not altogether, of Fixed Air, produce the most sudden and fatal consequences to animal life that we are acquainted with.

In answer, however, to this, we may alledge, that although I own the effects of *

* It has been lately discovered, by my learned and ingenious friend Dr. Percival, of Manchester, that Fixible Air differs greatly in its effects, according to the different substances from which it is procured. That although some kinds of it are suffocating and deleterious, others may be respired with safety, even when largely accumulated, and are so far from proving injurious to the lungs, that they furnish a powerful remedy in several of the disorders of those organs. Probably the Fixible Air contained in these waters is of some of those kinds which are innocent, or least injurious to animal life.

some

PART III. some kinds of Fixed Air, when accumulated in large quantity, to be as thus represented, yet, when united with a certain * proportion of common air, it becomes harmless, and may be even respired with safety. It is remarkable of Fixed Air, that its pernicious effects seem chiefly exerted when taken in by respiration, and that the same substance which, received into the lungs should induce an almost instantaneous † paralytic torpor on the vital organs, should, when taken into the stomach, prove a powerful and invigorating stimulant.

The celebrated effects of these waters, in restoring weak stomachs, and enabling them to retain food, are, in all probability, owing to this part of their impregnation,

* Perhaps to this admixture it is owing, in some degree, that the effluvia of the Bath, and other Waters, which contain Fixed Air in substance, do not, when taken in by respiration, exert any of the pernicious effects on the human body, belonging to this substance, in its separate state.

† This is to be understood of it only as taken into the stomach in a certain proportion, as even there, if accumulated in too great quantity, it exerts its effects similar to those produced by it, when taken in by respiration. Thus a small quantity of rectified spirits (for the time at least) stimulates and invigorates the stomach and powers of digestion, but if taken in over proportion, debilitates and hurts their faculties, and if the quantity be very large, induces a sudden paralytic torpor of all the vital powers.

To

To the dissipation, likewise, of this volatile substance may be ascribed the small effects which these waters produce when drank cold, or at a distance from the spring, compared with those produced by them when fresh.

The common saline mixture, called, from its effects antiemetic, affords a striking analogy to the effects of Bath Water in this respect, as this was found to exert none of its antiemetic qualities, unless taken during the effervescence; and by the account given of it by Sir John Pringle, its * antiseptic effects were much more observable, when taken in this manner, than after that had ceased. For this reason that learned and judicious practitioner has delivered an elegant formula for the exhibition of this preparation in the act of effervescence, whereby its effects of this kind may be best preserved.

On the whole, we may be assured, that Bath Waters contain Fixible Air in considerable proportion, and, probably, of the most innocent kinds. The King's Bath

* This is likewise confirmed by Mr. Macbride's Experiments.

seems

PART III. seems to contain it in greatest quantity, and the Cross Bath the least.

From a review of the above reasoning and experiments, I find, that out of the substances which are mentioned as possible native impregnations of Mineral Waters, those of Bath contain the following.

TABLE *of the* CONTENTS *of the* BATH WATERS.

1. Saline bodies.	{ Simple. 1. Vit. acid per fe, very dubious. Compound. 2. Common salt in small quantity.
2. Inflammable bodies.	{ 3. Hepar sulph. cum calce viva, in large quantity.
3. Metallic bodies.	{ 4. Iron.—One thirty-seventh and a half of a grain in a pint of the water.—Lucas. 5. Lead.—Qu. if this is not an accidental impregnation?
4. Earthy bodies.	{ 6. Selenites in large quantity.
5. Aerial bodies.	{ 7. Common air, probably both in solution or mixture and diffusion. 8. Mephitic air in large quantity.

PART

P A R T IV.

APPLICATION *of the WHOLE to the*
PURPOSES *of MEDICINE.*

I COME now to the last and most im- PART IV.
portant part of this Work, which is, to
give some account of the *purposes to which*
the Bath Waters may be applicable in Me-
dicine. This I intend to consider under
two heads; the first of which I propose
shall contain a description of the general
effects of the Bath Waters (when drank)
on the human body, with some conjectures
concerning the peculiar impregnation to
which these effects may be owing, and
some remarks on the different qualities of
the several waters, and on the probable
cause of these variations.

I shall next make a short application of
the foregoing to particular Diseases, and
shall subjoin a few observations on the cases
in which they are contraindicated, or
where their use would probably be preju-
dicial, or at least of no service. This I
shall endeavour to deduce from the known
effects

PART IV. effects of the waters on the human body, and the propriety, or impropriety, of using medicines calculated to answer such indications in such complaints.

I shall add, lastly, a short abstract of those species of Disorders in which these waters have been found of service in practice, and of those which, from analogy or reason, we might imagine likely to be relieved by them.

This last part is addressed principally to the Faculty, and I have taken the liberty of making use of Dr. Cullen's system, as contained in his Synopsis, lately published, which is the most clear and comprehensive of any that I have seen.

The candid reader will scarce expect a full discussion of the above articles in a Book of this kind. I mean no more than to offer my sentiments in general, and have made choice of the above-mentioned plan, only for the sake of reducing them to method. I am conscious that to treat the subject as it deserves would require a much greater share of abilities than what I can pretend to, and would, moreover, be too voluminous a work to be comprized within such
narrow

narrow limits. All I aim at here, is to give a short abstract of the Qualities of the Bath Waters, and of the Disorders in general to which they are principally adapted; and I flatter myself, that this Work may not be entirely useless, if it serves only as a sketch of a plan on which some future Writer may enlarge. PART IV.

Such is the plan of the first Chapter of this division of the Work, which may, in some respects, be called the *Medical Part*.

In the second Chapter, which may be called, though perhaps not strictly, the *Pharmaceutical Part*, I propose to treat of the methods by which these waters may be best managed, so as to answer, most successfully, the above indications in the cure of diseases. This I propose to pursue in the following order:

1. As to the choice of the waters.
2. The state of the waters when drank.
3. Quantity.
4. Time of day.
5. Length of time proper for them to be continued.
6. Season of the year best adapted to their use.
7. Regimen of life.
8. Substances proper to be used at the same time with the waters.

C H A P. IV.

S E C T. I.

*On the general Effects of the BATH
WATERS.*

PART IV. **T**HE first quality of the Bath Waters of which I shall speak, as being the most obvious, is their stimulant * one.

Their heat, brisk and poignant taste, and, if largely taken, inebriating effects, are great evidences of this, which are confirmed by their effects on the system. They accelerate and raise the pulse, increase the heat, and excite the secretions. So far as to their general effects.

But it may be doubted, if they do not possess a stimulus of a peculiar kind. The glowing sensation in the stomach perceived on drinking them, the sudden increase of strength often procured by their means, and, if too largely taken, the pain in the

* By Stimulants I mean such substances as excite the motion of the fibres in living animal bodies. All those medicines that go under the name of cordial are of this kind.

head which they occasion, indicate, that PART IV.
they are possessed of a degree of stimulus
of a particular nature, principally affecting
the nervous system, and not to be mea-
sured entirely by the pulse, heat, or in-
crease of secretions, since these are often
not proportionally affected. This is, in
my opinion, confirmed, by observation of
the effects they produce on the stomach
and appetite, when the strongest stimuli of
other kinds had been tried in vain.

From their immediate action on the
body, it appears probable, that they act in
this way through the intervention of the
stomach, to which their stimulus seems in
a manner specific. This quality is com-
mon to all the springs, but possessed in
least degree by the Cross Bath Water, and
in the highest, as is generally thought, by
that of the King's Bath. This varies in
some habits, but this difference is more
probably owing to peculiarity of consti-
tution, than any inherent quality of the
waters.

To what this quality may, with most
probability, be ascribed, comes next to be
considered.

PART IV. In my opinion, it is principally owing to its *aërial* impregnation. I do not deny that the chalybeate, and perhaps the sulphureous parts of the impregnation, and the heat of the water itself, may have some share, and, moreover, the junction of all these with the saline qualities, may form an united stimulus, different from what any of them would have exerted when separate; but I am still inclined to think, that the fixible air is the chief agent, and prime source of this quality. The chearfulness, and, if too largely drank, inebriating effects, similar to those we see follow the drinking fermented liquors, which are produced by these waters when fresh, and the loss of these qualities on standing, prove very plainly, that these effects are owing to a volatile part of the impregnation. The water, indeed, on standing, soon loses the chalybeate impregnation likewise; but this is too inconsiderable to have such powerful effects attributed to it. The water, indeed, on standing, seems to suffer a decomposition, and, consequently, a change of nature of the sulphureous impregnation also; but it loses its stimulant quality, in a great degree,

gree, before any signs of this appear. The PART IV.
aërial impregnation then appears to be the only one to which this quality can be ascribed, as it is a volatile substance itself, and agrees in effects, in a great measure, with those produced by these waters.

In all probability, the King's and Hot Bath are more stimulant than the Cross Bath, on account of their being more largely impregnated with this substance.

Another quality which the Bath Waters possess, is that of *astringent*. This is proved by their effects on the human body, costiveness being a very common circumstance attendant on their use. It is not improbable, likewise, that their effects in restoring the tone of the stomach and bowels, may in some degree be owing to this quality. Whether these waters be directly astringent, or whether they are only consequentially so on the bowels, owing to their increasing the heat, and raising and accelerating the pulse, and increasing the other secretions, perspiration particularly, is a doubtful case. I have some doubts if the King's Bath Water be not in its nature astringent, for the reasons

PART IV. given in the third * part of this Work ; but, exclusive of this, I doubt, whether any of them have much claim to such quality, except in a secondary view. But as they all are frequently found to exert this effect ultimately, it cannot well be denied that they have some title to the appellation. To what this quality in the waters is owing is difficult to ascertain. The King's Bath, which is most remarkable in this way, has been mentioned as lying under a suspicion of some impregnation with lead, which, if well founded, would amply account for this quality. I confess I am not fully satisfied that they do not all partake of a similar impregnation, though perhaps not in such a degree, since leaden pumps and pipes are common to all ; though in the Hot, and, I believe, the Cross Baths, the cistern is made of stone.

The chalybeate impregnation, likewise, may act in this way, but this is too slight to act so powerfully as is observed here. The heat, likewise, and stimulant qualities of the waters (dependant on the fixi-

* Vide article Lead.

ble air) promoting urine and perspiration, PART IV. must, as was before observed, of consequence diminish the evacuation by stool; and though I do not imagine any of the impregnations, of which we are tolerably well assured, can have any great power in this way, yet I will not absolutely deny, that, when combined, they may, in some constitutions, act directly on the system as astringents as well as stimulants.

The King's Bath is most remarkable for this quality, and the Hot Bath is generally thought to have the least of it.

Whether this be owing to any impregnation of Lead * in the King's Bath Water, which I mentioned before, (which is not in that of the Hot Bath) as being to be suspected, I cannot perfectly ascertain.

The Bath Waters in general likewise possess the quality of being *diuretic*. This quality is well known to most of those who have made trial of them, it being generally esteemed one of the best methods of their passing off, and such as generally indicates that the patient will receive benefit from

* Vide Part the third, article Lead,

PART IV. their use. They seem to possess this quality with no great peculiar stimulus on either the secretory or excretory organs of urine. I once thought that their action in this way was, in a great measure, mechanical, and owing merely to the quantity of diluting liquor taken in; but I am now convinced that they are endued with a great degree of diuretic power, arising from their own particular impregnations; and this is confirmed by observation of their great evacuating effects in this way, in dropical complaints, where a mere diluting liquor taken in large quantity would have had no such effect, and by its bulk would be thought highly improper.

What this quality is owing to is next to be considered; and here again I am inclined to ascribe their operation in this way principally to the fixible air. I do not deny that its stimulus is modified, and perhaps directed to the urinary passages by the saline part of the impregnation; but I am well satisfied that this effect is, in a great measure, owing to the fixible air, since I have observed, that the waters drank at home did not prove nearly so diuretic

diuretic as when drank at the pump, although moderate exercise, by walking about in a cool room, was used with them. I have likewise been assured by several, that the Bath Water, when drank at a distance from the place, exerted very little effect of this kind upon them, although when drank at the pump it shewed it in a high degree. PART IV.

But though I ascribe a peculiar diuretic quality to the Bath Waters, I confess that their bulk, and the exercise generally used with them, I mean the walking in a cool air during the intervals of drinking, as is generally done in the pump room in a morning, contribute, very powerfully, to determine the waters to pass off in this manner.

I have not been able to discover satisfactorily, which of the springs possess this quality in the greatest degree, though I think the Cross Bath possesses most of it, probably on account of its being least stimulant.

The Bath Waters are likewise *diaphoretic*, This quality of them is well known,

as

PART IV. as well as the foregoing, and probably both are modifications of their stimulant quality. In general, when a warm regimen, and rather sedentary manner of life is used, they prove diaphoretic; and when exercise, especially walking in a cool air, as before-mentioned, is joined with their use, they pass off by the kidneys. It is likewise observed, that their effects in this way are much directed by the weather. In warm seasons they are much more disposed (as indeed all stimulants are) to affect the skin than the urinary secretions, and the contrary is observed when the season is cold. But though these are their general effects, yet they are much varied by the idiosyncrasy, or peculiar disposition of the patient. I have observed several, who, having tried the waters in cool weather, and, perhaps, by that means given them a determination to pass off by the urinary secretions, in whom this disposition has not varied, even though the use of the waters was continued through a warm season. In general it is observed, that a determination to the urinary passages, though often difficult to procure, is, when gained, the most fixed and certain of any,

and

and perhaps to this is owing the difficulty of the cure of the diabetes. PART IV.

This effect of the waters is, probably, owing to the same cause with the foregoing, being, in all likelihood, as I before observed, both of them modifications of their stimulant quality. The heat of them indeed seems to favour this secretion more than the diuretic one.

I have not been able to determine, satisfactorily, in which of the springs this effect is most remarkable, though I think it more prevalent in the King's and Hot Bath than the Cross Bath.

Another quality of the Bath Waters is that of being *antispasmodic*.

I have not before observed, that this effect has been taken notice of as directly produced. Their efficacy in several spasmodic and nervous cases has been often remarked, but their effect in this way has been, I believe, ascribed to their strengthening the habit in general, restoring the secretions, and enabling nature to perform her several functions properly. But though I am well satisfied that they are
of

PART IV. of great service in spasmodic disorders, by means of the above-mentioned qualities, I am convinced likewise that, in some cases, they are directly antispasmodic. This is proved by their immediate effect in the colica pictonum, and those convulsive reachings which are often produced by the gout attacking the stomach, where their action is too immediate to be ascribed to any other quality. This is corroborated by observation of the great effect of antispasmodic medicines*, musk particularly, in the same complaints.

To what this effect is owing is difficult to determine. To me it appears chiefly owing to the aërial part of the impregnation, which seems to possess qualities at once stimulant and sedative, which is the foundation of most antispasmodics. Perhaps the qualities of the fixible air in this way may be modified by the saline and sulphureous parts of the impregnation. I think the Hot Bath possesses this quality in greatest degree. Whether this is owing to its being more free of any leaden im-

* Vide Essays and Observations, Physical and Literary, Vol. II, p. 259.

pregnation than the King's Bath, I shall not determine. PART IV.

Another quality of these waters, which I have not seen remarked by any one, is that of being *antiseptic*.

That they possess a property of this kind has been shewn by experiment*, and it does not seem improbable, that the good effects of the waters, in restoring weak and relaxed constitutions, may be in part owing to this quality, since a tendency to putrefaction is a very frequent attendant on a weak habit, and contributes, in its turn, greatly to favour the complaint.

The change of the consistence of the fleshy and muscular parts of the body, from a soft and flabby to a † firm and hard one, which is an effect frequently produced by the Bath Waters, are great evidences in favour of this opinion.

What is the foundation of this quality remains now to be considered, and here I can have no doubt in ascribing it prin-

* Vide Experiments on the Bath Waters, Part III.

† Vide M'Bride, on the Powers of Antiseptics.

PART IV. cipally to the aërial part of the impregnation, since fixible air has been found a powerful preventer, and even corrector of putrefaction, both which qualities seem to be possessed, in some degree, by the Bath Waters. The saline, and even chalybeate part of the impregnation, may, perhaps, have some effect in this way, but I imagine they are too slight to cause much perceptible difference.

By experiments, the King's and Hot Baths appear to possess this quality in a much greater degree than the Cross Bath, which is, probably, owing to their being more largely impregnated with fixible air.

SECONDARY QUALITIES *of the* BATH WATERS.

Such are, in my opinion, the general qualities of the Bath Waters; but they also possess several others of a secondary nature, which are not so frequently exerted, and which likewise are either mechanical, or, in a degree, dependant on those already mentioned. Thus, in cases of viscosity of the fluids, owing to their stagnation, from an inertia of the vessels,

or

or from retention of the proper excretions, PART IV.

Bath Waters, as exciting the motion of the vessels, increasing the secretions, and diluting the consistence of the fluids in general, may prove *attenuant*. By their stimulant and astringent qualities strengthening the stomach and organs of digestion, and preventing the fermentation of the food, they are frequently *antacid*. In cases likewise, where, from weakness, the peristaltic motion of the bowels is slow, Bath Waters, by their astringent and stimulant quality, restoring their tone, and exciting this motion, prove *cathartic*. This effect likewise is in part mechanical, owing to their bulk, and, in this way, simple water will have the same effect. In cases likewise of the bilious kind, where, from spasmodic constriction of the biliary ducts, the bowels are deprived of their accustomed stimulus, the bile, and of consequence a costive habit, follows; Bath Waters, by relaxing the spasm, gain a passage for that into the intestines, and prove in this way *purgative*, by means of their antispasmodic quality.

Bath Waters, likewise, as increasing the secretions by their stimulus, sometimes
promote,

PART IV. promote, among the rest, the secretion of mucus in the lungs, and are in this way expectorant* ; and I think I have seen it do service in this way, in some old gouty coughs, as promoting the crisis of the disorder by these means. I have likewise seen it have this effect with advantage in the catarrhus senilis, and some other catarrhal complaints, not of the pulmonary kind, and unattended with heat or fever. These waters likewise, as increasing the secretions, promote the salivary discharge likewise. This effect I believe seldom happens in a great degree, though I have more than once seen it occur. In this light, then, they may be esteemed *salagogue*.

Another effect of the Bath Waters is that of proving *emmenagogue*. This they produce by several means. The obstruction of the menstrual flux is frequently owing to, or attended with, a lax and weak system of the uterine vessels, and, in order to remove the obstruction of it, it is always ne-

* Expectoration is sometimes stopped or prevented by a spasmodic contraction of the lungs. Perhaps in this case the action of the Bath Waters may be owing to their antispasmodic quality.—*Qu.* Do not *asafoetida* and *gum ammoniacum* owe their expectorant virtue to their antispasmodic quality.

cessary to remedy the flaccidity. The Bath Waters then, as astringent and tonic medicines, are of great service, as they restore the necessary constriction, which increases the impetus of the system without inducing a spasmodic affection. When this disorder proceeds, as it often seems to do, from a languor and inertia of the system in general, the Bath Waters are often efficacious in restoring this evacuation as *stimulants*, though I cannot say that I can discover any peculiar or specific stimulus of this kind that they possess. I imagine, likewise, that the Bath Waters prove *emmenagogue* in another manner. This discharge, though often owing to a flaccidity of the vessels, is sometimes owing to a spasmodic constriction; and here I imagine the Bath Waters, like musk, castor, and the foetid gums, act by their antispasmodic quality.

S E C T. II.

On the INDICATIONS to which the BATH WATERS are adapted.

Having thus premised a general view of the effects of the Bath Waters, I shall now consider the Indications to which they are

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adapted,

PART IV. adapted, with a short application to particular disorders, and shall subjoin likewise some observations on the cases in which they are contraindicated, or where their use would probably be prejudicial, or at least of no service.

I shall pursue, in this application, the same order which I have done in treating of their effects.

The Bath Waters are in general indicated as stimulants, in cases of languid motion, and this not only as merely the consequence of weakness, but in many other cases where the moving power of the system is inert and slow. As this indication is the most extensive, I shall consider the effects of the waters as stimulants, and exerting this power under three heads: 1. Their effects on the system of the blood vessels. 2. Their effects on the nervous system. 3. Their effects on the alimentary canal.

As to the first of these, the Bath Waters are indicated in cases of permanent langour, such as arises from, or is attended with, a slow circulation of the fluids. Of this

this kind are those disorders which go PART IV.
under the name of cachectic.

The most simple of these is the Chlorosis incident to women, which seems to be owing to, or at least always attended with, a slow motion of the vessels. This disorder is indeed sometimes owing to a local affection of the uterus, but often to other causes likewise. In that species of it which is attended with paleness, diminution of strength, and depraved appetite, the Bath Waters are generally successful, and may be used in all cases where chalybeate medicines are proper.

The Bath Waters are likewise of great service in cases where this inertia of the vessels has increased to such a degree as to produce obstructions of the viscera. These appear to be frequently owing to this origin, especially in the female sex in general, and often happen in consequence of neglect of the former complaint. The parts generally affected in this way are, the liver and mesenteric glands, and sometimes the spleen.

In all these, if used before the inflammatory disposition takes place, they are

PART IV. generally of great service when cautiously managed, gently stimulating and exciting the vessels into action, which contributes to remove the obstruction, and taking off that inertia from the system in general which is so frequently attendant on, and so much contributes to increase, the complaint. The Bath Waters are likewise indicated in cases, where, in consequence of the above-mentioned inertia, a stagnation of the fluids in particular parts has taken place, as in œdematous complaints, owing to this cause, such are frequently called low, weak, phlegmatic cases. Of this kind are those œdematous swellings of the legs, and sometimes of the body, which we often see succeeding intermittent, and sometimes continued fevers, in which the Bath Waters are of signal service. The like symptom often takes place after a fit of the gout, for the relief of which the Bath Waters are the best remedy. In these, if tried before the disease is too far advanced, they are extremely efficacious, by their stimulus exciting the exhalent vessels to contraction, increasing the action of the absorbents, and encouraging the fluids to pass off

off by the proper secretions. I shall now PART IV.
proceed to speak of their effects in this
way on the nervous system.

As the Bath Waters are found serviceable in exciting the motion of the vessels when languid, they likewise are efficacious in inertia of the nervous system. Paralytic disorders are of this kind, in which the Bath Waters, as stimulants, have been found of the greatest service, and, if judiciously managed, may be exhibited safely in most of the kinds of this complaint. They are peculiarly serviceable (when drank) in those cases where the affection arises from disorders of the bowels, as in those arising from the bilious cholic, and those which proceed from fumes of metallic substances, as arsenic, copper, antimony, lead, and mercury, where their effect seems to proceed from the action of these substances on those viscera. They are likewise indicated in those paralytic complaints which follow fits of the gout and rheumatism.

The waters are likewise of great service in those paralytic complaints which occur in weak habits, such as were formerly

PART IV. called nervous, and often occur, in consequence of low and watery diet, damp situations, new built houses, and which often happen among those whose business obliges them to remain in water, or moist places for a long time together, as washerwomen, fishermen, &c.

Such are the kinds of paralytic complaints, in which the Bath Waters, taken inwardly, seem chiefly indicated; but they are, undoubtedly, of great service in many more; and I am well satisfied, that in almost every kind of palsy whatever, when judiciously managed, that they may be employed with advantage.

Connected with paralytic disorders are the apoplexy, lethargy, and other disorders of a like kind, in which likewise these waters are often of especial service.

The apoplexy has been divided by writers into the sanguineous and serous; and stimulant medicines have been thought proper in the latter only. I believe there is a foundation for a distinction of this kind, yet I am well assured that the Bath Waters are of great service in both these, in the latter immediately, and in the former after
due

due evacuations; and I make no doubt PART IV. that these waters, though very likely to bring on this disorder in a plethoric habit, if improperly used, may nevertheless be of the greatest service in preventing their access, if judiciously managed, and this not only in the serous apoplexy, but in the sanguineous kind also, and I think I have seen signs of their approach obviated by the use of them.

I shall next speak of the efficacy of the Bath Waters as stimulants, in disorders of the alimentary canal.

The Bath Waters are of the utmost efficacy in all disorders that depend on the inertia of the organs of digestion. This is the source of many complaints, such as are generally called of the stomach, and acescency proceeding from the same cause, and the food's making too long a stay in the body.

In these complaints the Bath Waters are generally of great service, especially of of that kind which is produced by hard drinking, in which case the Bath Waters often exert a peculiar effect, exciting the

PART IV. stomach and bowels to perform their functions, when the strongest stimulus of other kinds had been used without effect. They likewise eminently relieve the costiveness, which so often attends a bad digestion, by restoring and exciting the peristaltic motion of the bowels to propel the food, and thus prove evacnants by means of their stimulus. I shall speak more of their action on the stomach when I speak of their astringent and antispasmodic qualities.

There is likewise another kind of languor, or inertia, in which the Bath Waters are of great service, which may be referred to this head; I mean the Gout. The nature of this disorder has been hitherto very imperfectly explained; but so much is certain, that it is peculiarly connected with the stomach, a certain strength and tone of which is necessary to produce the gout in its proper situation, the extremities. The Bath Waters are found, by experience, to be the best and safest medicines for this purpose yet known; their stimulus on the stomach being immediate and peculiar, restoring to it such a degree of tone as enables it to send the gout into
its

its proper place. On this account the Bath Waters are of the greatest service in erratic gouty complaints, especially those wherein the gout attacks the noble parts, from an inertia of this organ, produced by excess in drinking fermented liquors, and exceed, in this respect, any medicine hitherto known.

PART IV.

I shall next speak of the cases wherein the Bath Waters are indicated as *astringents*.

They are indicated in this respect, in debility and laxity of the moving fibres, as in the rickets, in which case they have been often of great service. They are likewise indicated in the weakness which often succeeds large evacuations either of blood, stool, or perspiration, either artificially produced, or owing to nature. This often takes place after feverish disorders, wherein large evacuations, though necessary at the time, yet in their consequences are prejudicial, in exhausting the vital powers. In restoring these the Bath Waters are very successful, and often prevent dropical complaints, which so often occur in such circumstances.

They

PART IV.

They are likewise equally efficacious in such circumstances, when occurring in consequence of weakness brought on by large evacuations, whether of blood or perspiration, in lying-in women.

The Bath Waters are likewise indicated as astringents in increased evacuations depending on laxity of the solids, or debility, and consequent irritability of the moving fibres. Of this kind are frequently the alvine evacuations, where a diarrhœa continues merely, as it seems, from an inability in the intestines, owing to laxity, to retain the food a sufficient time in the body. This often takes place after large evacuations of any kind, but principally after violent alvine evacuations, either natural, or procured by medicine. In these complaints, when unattended with fever, the Bath Waters are of the utmost service, and have often restrained fluxes of this kind, when the common astringents have been used without success.

They are likewise of great service in habitual laxities not owing to these causes, but merely produced by a lax, and, possibly, on that account irritable, system of the
in-

intestines. In these cases the Bath Waters, PART IV. by their astringent quality, take off the flaccidity, and enable the intestines to retain the food, and, by restoring their tone, take off the irritability which produces the disposition to frequent evacuations, and thus prove antispasmodic, by means of their astringent quality.

The Bath Waters have been likewise of great service in restraining evacuations by the urinary passages, as well as stool. They have been found efficacious in the diabetes, when all other medicines had failed, even the strongest astringents.

They have been no less efficacious in restraining that disposition to perspiration, which sometimes attends people of a lax and irritable habit, and is very weakening, though unaccompanied with a hectic fever.

Bath Waters are likewise efficacious by this quality, in restraining the fluor albus, and have often cured this obstinate disorder in the most unpromising circumstances. They generally succeed best when the constitution will bear their stimulant as well as astringent qualities.

From

PART IV. From analogy we may conclude, that they are likely to be of service in involuntary seminal evacuations.

Another quality which the Bath Waters possess, of great consequence, is their *diuretic* one. The free passage of the waters, by this excretion, has been generally esteemed a happy presage of their effects in most complaints. But I am well assured that they are peculiarly adapted to some cases by this quality.

Their diuretic power renders them especially serviceable in disorders of the dropical kind, which are frequently relieved by it, notwithstanding the apparent impropriety of using a medicine that contains so large a proportion of watery fluid.

In anasarous cases, when recent, and a good degree of strength remains, they are generally successful, and prove the most effectual evacuators of the water, at the same time as, by their astringent quality, they contribute very much to guard against a return of the disorder; nay, instances are not wanting where Bath Waters have been found successful in the most advanced stages of
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of this complaint, when large quantities were used; and I am almost inclined to believe, both from theory and the history of diseases, that they were more efficacious formerly, when drank in large quantities, than they are at present, since custom has diminished the quantity in which they are taken *.

They have been found peculiarly successful in those dropfical complaints which arise from a suppression of some of the natural evacuations. Of this kind are those which happen from a check of perspiration, which are frequent among those who have changed their residence from a hot to a cold climate, and such are generally relieved by the use of Bath Waters. Another case of this kind is, when a dropfical complaint comes on in consequence of the stoppage of the menstrual

* The numerous cures, by the Bath Waters, of dropfical disorders, even in their last stage, induces me strongly to think, with Dr. Heberden, that Physicians are in the wrong to restrain the drinking largely of diuretic liquors, and that the thirst, which attends these disorders, ought to be considered, as in fevers, an indication of nature towards their cure. It is observed of several diuretic substances, particularly nitre and cantharides, that they are most efficacious as diuretics, when diluted with a large portion of water.

PART IV. evacuation, and in this too they have been found very efficacious.

They are likewise of great service in the same complaints, arising from an opposite cause, such as an increased evacuation, as by blood, stool, or perspiration, and in those which sometimes succeed fevers, (especially of the intermittent kind) and immoderate discharges after delivery, or loss of strength, by too great discharge by perspiration or purging at these times.

I am likewise inclined to attribute their effects, in some cutaneous disorders, to this quality. They have been long famous for their effects in leprous complaints, in which diuretics, as hath been observed by Dr. Mead, are of great service, and on this quality depends the effect of tincture of cantharides, which is often successfully given in this disease. Their diaphoretic, and, perhaps, antiseptic qualities, may have some effect here, but I imagine the diuretic quality is the most material. These waters are likewise often successfully administered in scrophulous complaints, and it is not, in my opinion, improbable, that their success in that disorder may be owing

ing to their diuretic quality. If acrimony PART IV.
of the fluids be, in any case, the cause of
disorder, it seems as likely to be present
here as in any; if so, the action of the
Bath Water, in curing this disorder, is
most properly attributed to this quality,
since, by it, they revacuate the acrimonious
particles, which, in general, adhere to
the serosity which is passed off by urine.
Perhaps they may act also by their bulk
as diluents, abating, by this means, the
stimulus of the acrimony, and, by their
quick passage, washing out the acrimonious
particles from the lymphatic glands, and
evacuating them by the urinary secretions.

What makes this account of their mode
of operation more probable is, that even
common water, largely drank, has been
of great service in this disorder, which
could only be owing to its effect in wash-
ing out the lymphatic system. But the
Bath Waters are found more efficacious,
probably, in some measure, as they are
sooner evacuated, from their peculiar di-
uretic quality. They are likewise of great
service in some of those disorders which
are commonly called scorbutic, and are
attended

PART IV. attended with some signs of putrescency, such as flaccid gums, subject to hæmorrhage, loose teeth, &c. In all probability their diuretic quality is of great use here, since, by that, they evacuate the saline putrescent part of the blood, and hence diuretics in general are found to be antiscorbutic.

Probably to this quality likewise, may be, in part, referred, their good effects in obstructions of the liver. The use of diuretics in these disorders is well known, but this effect in general is very difficult to be accomplished, as the urine is most commonly secreted in small quantity, and a considerable degree of languor and insensibility is generally spread over the system which is difficult to overcome. In these cases the Bath Waters, if tried in the beginning of the disorder, before any inflammation or confirmed obstruction has taken place, are generally successful, proving the best diuretics, and by that means evacuating the saline parts of the blood, grown acrimonious by long retention, and, by being mixed with the bile, regurgitated into the course of circulation. They likewise

wife wash out their lymphatic system of the liver as diluents, and, as stimulants, take off that inertia so common in bilious complaints. They are likewise of great service, by this quality, in some gravelly complaints. In those disorders of this kind, where the sand is of the red sort, and, though generated often in great quantity, does not seem disposed to concrete, these waters, by their diuretic quality, which they exert without any inflammatory stimulus on the urinary organs, prove of great service, especially if used in the intervals of the paroxysms. PART IV.

In these cases they are often of infinite service in discharging the gravelly concretions from the kidneys and bladder in large quantity, and with more safety than any other diuretic.

The Bath Waters seem likewise, in many cases, indicated, on account of their *diaphoretic* quality. Probably their great effect in stopping, or moderating habitual laxities of the bowels, may be owing as much to the restoring the determination of the fluids to the surface, as to their astringency; and, in all probability, the same

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quality

PART IV. quality is of great service in the cure of those spontaneous vomitings of the food which we see so much relieved by these waters. Their diaphoretic quality is, undoubtedly, of great consequence in this case, from the great consent between the stomach and bowels and the surface of the body. It is generally observed in these cases, that the skin is dry and parched, and that the restoration of perspiration is the best sign of recovery. Sydenham found, that in violent retchings all medicines were in vain until a degree of perspiration could be procured; and it is probably owing to the diaphoretic property that ipecacuanha proves so serviceable in the diarrhœa and dysentery. Probably, therefore, it is on account of this quality that the Bath Waters are so serviceable in habitual evacuations of this kind, unattended with fever.

It is not improbable, that the good effects of the Bath Waters in the diabetes, may be in part owing to their changing the tendency of the fluids from the urinary to the perspiratory secretions. The Bath Waters, likewise, have been found a powerful remedy for that kind of dropsy which
often

often happens to those who changed suddenly a hot for a cold climate, and is, with great probability, attributed to the check given to perspiration by that means. In hot climates Nature seems to have acquired a habit of passing off a great part of the excrementitious fluid by means of the skin; and when this passage is obstructed, as in this case it is, in a great measure, by cold, which here constricts the pores more than in the case of those who have been accustomed to the climate, on account of their greater sensibility to it, they do not easily pass entirely off by the other passages, and, by being thus confined in the body, cause dropsy. A dryness of the skin, and defect of perspiration, is a general symptom of dropsy, and it has been long observed, that the restoration of perspiration was a great step towards a cure.* This the Bath Waters, if tried before the disorder is too far advanced, accomplish very successfully, and prove the most effectual cure for the dropsy by these means. They are, probably, serviceable in all dropsies by this quality, but seem more particularly adapted (as diaphoretics) to that kind just mentioned,

PART IV. tioned, which seems more evidently to arise from an obstruction of perspiration.

They are likewise found of great service in those cutaneous eruptions which often come on after a sudden check given to perspiration, and which generally affect the face, and are frequently produced by a draught of some cold liquor taken during a copious perspiration. This is most probably owing to the perspirable matter accumulated in the glands, and by the sudden constriction induced retained there, and by its stagnation growing acrimonious, and irritating the parts surrounding.

The face in this disorder is principally affected, probably from the large perspiration that generally is produced from it, and likewise as it is subject, being uncovered, to frequent interruptions of this evacuation by cold.

In these cases the Bath Water proves the safest and most effectual cure, since they, by restoring the perspiration, procure an exit for the acrimonious matter; whereas other applications that have this effect produce it as astringents, by causing
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it to be absorbed into the vessels, where it is productive of the worst consequences, generally producing a disorder of the consumptive kind. PART IV.

Another complaint wherein the Bath Waters are, in my opinion, strongly indicated as diaphoretics, is the *rheumatism*; by this I mean that kind, or at least that stage of it, which is not attended with any considerable degree of fever or inflammation.

To restore perspiration, or at least a certain degree of determination to the surface of the body, seems obviously an indication in many rheumatic cases, since the stoppage of it is so frequently the evident cause of the disease.

Thus we see no complaint so frequently induced as this, by damp bedding, sudden exposure to cold, blasts of air on any particular part of the body, &c. and it is found by experience that diaphoretic medicines give the most effectual relief, and hence is derived the efficacy of Dover's powder*, and the antimonial preparations.

* Vide Sydenham, p. 272.

PART IV. Towards the decline of the inflammatory diathesis the Bath Waters generally are very successful, both in alleviating the pain, by promoting a diaphoresis, and by their strengthening qualities preventing that weakness which is so apt to remain on the part after an attack of this disorder. They are likewise very useful in restoring the strength, and thereby enabling the patient to make use of his limbs, which is found to be the best preventer of that rigidity which is so apt to follow fits of this complaint, and arises from the disuse of the limbs, owing to the difficulty of moving them.

I shall now speak a few words concerning the efficacy of the Bath Waters, as given with this intention in the Gout. I have before spoken of their power in throwing the gout from the vital parts upon the extremities, when I treated of them as stimulants, and I believe their effects in allaying the pain, and carrying off the paroxysm, as diaphoretics, are not less remarkable. They second, in this respect, in an admirable manner, the intention of nature, promoting, in a mild and easy, but effectual manner, that gentle diaphoresis mentioned

mentioned by Sydenham as the most favourable method of the paroxysms going off, and do not, like other evacuants, weaken the body at the same time, but, on the contrary, strengthen greatly the vital powers. PART IV.

Their effect in this way is very great, in giving a full and compleat termination to the paroxysm, and by that means rendering the intervals more compleat, and the limbs, in consequence, less liable to become rigid, than could be attained by the application of any other medicine.

I shall now consider the Bath Waters relative to their antispasmodic quality.

This property they undoubtedly possess in a considerable degree, though their use seems more adapted to those cases which proceed from affections of the viscera, than where the nervous system in general, and sensorium commune are primarily affected.

Thus these waters are of the greatest service in hysteric and hypochondriac complaints, arising from a weak stomach and digestion, and thus prove in their con-

PART IV. sequence antispasmodic; but they are likewise in many cases directly so.

They afford a very immediate relief in the hysteric colic, which is generally attended with spasmodic affections, and have given the most immediate ease in bilious vomitings, which are often of the spasmodic kind.

But their most remarkable effect in this way is in the colic of Poitiers*, commonly called the dry belly-ach. This disorder is always attended with a spasmodic constriction of the bowels, which are the seat of this disorder. In removing this, the Bath Waters have been much more efficacious than any other remedy, and have often obtained a passage through the body, when the strongest purgatives, even when mixed with antispasmodics, had been tried without success†. This disorder, from whatever cause it arises,

* For a confirmation of the good effects of Bath Waters in this complaint, vide Medical Transactions, vol. ii. p. 81—89. Dr. Warren's paper on the Colica Pictonum.

† The constriction of the bowels in this disorder is not owing, as some have thought, to a paralytic affection induced on them, but to a spasmodic constriction, which is proved by the relief of this symptom by opiates.

seems

seems particularly suited to these waters, PART IV. which, if taken before it be too far advanced, prove an almost certain cure*. I am likewise inclined to attribute their effects in icterical complaints very much to this quality of them. A jaundice is frequently owing to a spasmodic constriction of the biliary ducts, by which the bile is prevented from passing into the intestines, and regurgitated into the blood. In these cases the Bath Waters often give almost immediate relief, relaxing the spasm, and opening a passage for the bile, by its proper exit, and thus curing the disorder. They are likewise of the greatest use where the gall ducts are obstructed by biliary concretions. In this case, the duct, though capable of considerable dilatation, is frequently spasmodically contracted by the irritation of the biliary calculus, which is detained in its passage by that means, and occasions exquisite pain in procuring a passage. For these the Bath Waters are of the greatest service; and I believe more gall stones have been observed to be voided during a course of the Bath Waters, than

* Curationem absolunt sulphure devites, Thermæ omni medicamine præstantiores, *Tronchin de Colica Piætonum.*

PART IV. any other known medicine. A solvent of gall stones in the body has been generally, and, I believe, with reason, looked on as impracticable, since they lie so much out of the reach of medicine, as Dr. Heberden has properly observed*, and on this account the experiments made on these substances, out of the body, have been justly regarded as frivolous and unsatisfactory.

I imagine that an ingenious and learned writer considered the Bath Waters in this light, when he represented them as useless in this complaint. For with respect to their efficacy in removing the symptoms, there can be scarce more doubt with any person who has had an opportunity of observing their effects, than of the Peruvian bark, in removing an intermittent fever. They powerfully promote the passage for the bile into the intestines, relaxing the duct by their antispasmodic quality, and, by their gently stimulating one, promoting the resorption and excretion of the bile, and by washing out the lymphatic system

* Vide Medical Transactions, vol. ii. on Diseases of the Liver.

they

they remove obstructions of the liver, and thereby prevent many of the ill consequences that arise from thence, such as scirrhus, inflammations*, &c. PART IV,

One great advantage which attends the use of the Bath Waters in this complaint is, that they may be used in general with great freedom through the course of it, provided no scirrhus, or actual inflammation of the part, has taken place, since there is otherwise no danger to be apprehended from their stimulus. Dr. Heberden has observed, that the pulse is very often scarce quickened by the most violent pain excited by the difficulty of passing a biliary concretion, and in general the pulse is below the standard, and of course their stimulant quality is rather beneficial than injurious.

Hysteric disorders, and menstrual obstructions, likewise, are frequently owing to spasmodic constriction of the uterine vessels. In relieving this complaint, when proceeding from this cause, the Bath Wa-

* Magnâ enim copiâ potatæ hæ aquæ (medicatæ scilicet) venis bibulis intestinorum resorbtæ cito integris suis viribus, pro magna parte, in venam portarum veniunt, & sic per omnia hepatis loca distributæ solvunt impacta, & vasa obstructa referant.

VAN SWIETEN, vol. iii. p. 346.

PART IV. ters are of especial service as antispasmodics, and are very frequently successful where they proceed from an increased irritability of the nervous system.

On this account they are often of great service in those obstructions which occur at an early period of life, and in hysteric constitutions. Sydenham * advises them as the last resort in this disorder.

In these cases, then, the Bath Waters prove emmenagogue, in consequence of their antiseptic^{menstrual} quality.

The Bath Waters, I imagine, are also often of the utmost service in the gout, by means of this property. When this complaint attacks the stomach, it frequently appears in form of a spasmodic affection. In this case nothing is more efficacious in throwing it back into its proper situation than the Bath Waters. Their action in this case is too sudden to be attributed to any other mode of acting than their effect on the nerves of the stomach, and that this effect is produced in consequence of their antispasmodic quality, appears probable,

* P. 411. Diff. Epistol. from

from the great effect of antispasmodic medicines, particularly musk, in similar circumstances. PART IV.

The last quality of the Bath Waters, of which I shall speak, is that of being *antiseptic*. This quality they do not appear to me to possess in a degree sufficient to make them particularly indicated on that account; nevertheless, I cannot help thinking, that it may in some cases contribute to the cure of some disorders, in which these waters are found by experience to be serviceable.

Thus it does not seem improbable, that the efficacy of these waters in cutaneous eruptions, which are frequently attendant on, and often produced by, a scorbutic habit of body, may be owing, in some degree, to the antiseptic power of the water correcting the putrid tendency of the humours of the body. This appears to be the case also in their effects on the body in cachectic complaints, which are frequently attended with this disposition, the change of which is no small step towards the cure of the disorders. The like appears to take place in many other weak and debilitated cases, which these waters so eminently relieve.

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CIRCUMSTANCES *in which the BATH
WATERS are contraindicated.*

PART IV. Having thus spoken briefly of the general circumstances in which these waters are indicated ; I shall now subjoin a few observations on those cases in which they are contraindicated ; and first of them as stimulants, as being that quality of them which is the most obvious and remarkable.

As these waters were indicated, in cases where the motion of the system was languid, it follows in general, that where this is preternaturally increased, that they must be improper. Thus they are, in general, improper in all diseases, owing to, or attended with, an increased impetus of the fluids, and in every circumstance where this disposition prevails.

This is plainly shewn in their effects, when imprudently taken, during a cold or feverish complaint, the symptoms of which they are found greatly to aggravate. In general it may be laid down, that where the pulse and heat, the last especially, exceed the common standard in health in any considerable degree, there the use
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of the waters is improper. They are PART IV.
likewise injurious in cases, where, although
no inflammatory complaint is actually present,
yet such a disposition exists in the system,
as is the case in phthifical complaints of the
pulmonary kind, wherein the use of these waters
is particularly dangerous.

They are likewise forbidden in cases where
the motion of the system is partially too strong,
as in all topical inflammations, wounds, recent
gangrenes, &c. which are greatly increased by
their use. This holds true of cancers particularly.
The gout, indeed, is an exception to this, because
inflammation is the only salutary form in which
it appears, and the Bath Waters, by increasing
this only, encourage it to go off in the manner
intended by Nature.

They are moreover improper in all cases, where,
although no inflammation or inflammatory disposition
prevails, yet where the exciting the motion of the
system would be attended with hazard, as is the
case in hæmorrhagy*, in which they

* This holds true of the venereal disease also.

PART IV. are very dangerous, and which they are found to excite very powerfully. They are likewise, for the same reason, to be avoided in plethoric habits, wherein all the vessels are distended with a large quantity of blood, and its return to the heart obstructed in some degree, or rendered more difficult by the pressure of the fat on the venous system. The Bath Waters, when used imprudently in cases of this kind, without some previous evacuation, by increasing the impetus of the fluids, cause ruptures of the blood vessels, in the head especially, and cause, in consequence, lethargy and apoplexy.

They are likewise very dangerous on this account, to those who have a disposition to maniacal disorders, proceeding from, or attended with, inflammation of the brain, or its membranes. The stimulus of the Bath Waters, as well as spirituous liquors, seems to be particularly exerted on the sensorium commune, as is evident from the similar effects of both, such as vertigo and giddiness, and if largely taken, a degree of intoxication. As the use of spirituous liquors is particularly
hazard-

hazardous in this complaint, it is reasonable to suppose that the Bath Waters must, in such cases, be improper or dangerous. PART IV.

For the same reason the use of the Bath Waters is forbidden in confirmed obstructions of the abdominal viscera. When we are certain that any such actually exist, this caution is, undoubtedly, proper, as in the case of scirrhus, in which case stimulants of all kinds are highly injurious, and tend rather to fix than remove the obstruction. But I am inclined to think, as well from observation as theory, that this caution is too much attended to, and that the Bath Waters, as well as the Bark*, have got a character which they do not deserve. This prejudice seems tolerably well got over, with respect to the bark, which is now found to be the best method of preventing the obstruction it was formerly thought to promote; and, I hope, that the same will be the case with these waters, which, I am well satisfied, may be given with greater safety, and more efficacy, in beginning obstructions, such as we commonly see in cachectic cases, than the gum

* Vide Cleghorn's Diseases of Minorca, p. 202.

PART IV. pills, soap, aloes, &c. which are generally given, and there are few so unexperienced, as not to know how often without success.

I am greatly inclined to suspect, that much time is often wasted in attempting to remove obstructions of this sort, the very existence of which is very often only imaginary, by means of this kind, previous to beginning a course of these waters, when the principal and best remedy has been withheld, under a notion of its dangerous consequence.

Indeed, I cannot think that the Bath Waters, in these cases, would be more dangerous than the fætid gums, aloes, &c. whose heating qualities are well known, and are not, at the same time, corrected by so great a diuretic quality as prevails in the Bath Waters, which is observed to be the most salutary evacuation in disorders of the glandular kind.

I am well satisfied, both from reason and experience, that the Bath Waters may, with more safety and greater efficacy, be exhibited in these complaints than mercurial preparations, which are so frequently given, and which are well known
to

to be so prejudicial in scirrhus and cancerous complaints, (which always owe their rise to glandular obstructions) and in which their use is now very properly laid aside. The Bath Waters are also contraindicated in cases where the solids are very tender and friable, rupturæ proximæ, as it is called, and the fluids very thin and acrid, which sometimes takes place in a high degree of the scurvy.

In these cases all medicines that suddenly increase the motion and impetus of the fluids in general are prejudicial. We do indeed give some kind of stimulants with success in this complaint, as some of the filiquose plants, scurvy grass, horse-radish, but then they are of such a nature as only to promote some particular excretions without extending their effects over the system.

In this case the mischievous effects of their stimulant quality would more than counteract the qualities whereby they might be serviceable in other respects.

The Bath Waters likewise are sometimes contraindicated on account of their astringent quality. I knew a person myself, who had a costive habit so increased by

PART IV. their use, as to admit of scarce any relief while they were continued, and on that account was obliged to leave them off. But in general this symptom is easily relieved, by proper medicines used at the same time with them.

I have likewise heard of one person in whom their diuretic quality was increased to so great a degree as to prove detrimental; and of another who was injured in like manner, by their increasing the perspiratory evacuation. But I am well assured that these instances occur too rarely to form any judgment in what cases they are contraindicated, merely on account of their too great increase of these evacuations. Such are the cases in which I think the Bath Waters contraindicated, or likely to prove peculiarly injurious. I do not pretend to recite all the circumstances in which they are not likely to succeed, but I imagine this will be understood in general by such not being mentioned among those in which they are indicated.

I shall next subjoin, for the use of the Faculty principally, a list of the species of disorders, according to Dr. Cullen's System, in which the Bath Waters are likely to succeed.

S E C T.

S E C T. III.

PART IV.

TABLE of DISEASES in which the
BATH WATERS are likely to be
serviceable.

CLASSIS I.

PYREXIÆ.

ORDO I.

PHELGMASIÆ.

GENUS XXII.

RHEUMATISMUS.

IDIOPATHICÆ.

Rheumatismus vulgaris. Sauv. spec. 2.

The Bath Waters are very serviceable here, both during the paroxysm and in the intervals*.

——— *arthriticus.* Sauv. sp. 3.

The Bath Waters are here of great service, and may in general be used through all the stages of this complaint†.

* The use of thermal waters *drank* is here recommended by Sauvage.

† Sublevatur thermis sulphur eis internè sumptis. Sauvage.

PART IV.

Arthritis rheumatica. Sauv. sp. 3.

The Bath Waters are of great service here.

Lumbago rheumatica *. Sauv. sp. 1.

The Bath Waters are well suited to the intervals and decline of the inflammatory stage of this complaint, but are in general rather too heating to be used during the paroxysm.

Ischias rheumaticum. Sauv. sp. 10.

The Bath Waters seem well adapted to all the stages of this complaint.

Ischias sanguineum. Sauv. sp. 2.

This species is well adapted to a trial of the Bath Waters.

Pleurodyne rheumatica. Sauv. sp. 3.

This seems tolerably adapted to the Bath Waters.

SYMPTOMATICÆ.

Rheumatismus scorbuticus. Sauv. sp. 3.

I should think the Bath Waters more likely to relieve this symptom, than the

* Intus thermæ sulphuræ profunt. Sauvage.
mercurial

mercurial course advised by Sauvage and Dr. Lind. I am confident they might be tried more safely. PART IV.

Lumbago scorbutica. Sauv. sp. 11.

This seems of a similar nature with the foregoing, and well adapted to a trial of the Bath Waters,

Rheumatismus calidus *. Sauv. sp. 5.

This species is well adapted to the Bath Waters.

Rheumatismus metallicus. Sauv. sp. 10.

This symptom is much relieved by the Bath Waters,

GENUS XXII.

ARTHRITIS.

ARTHRITIDIS VARIETATES.

I. PRO TEMPORE ANNI.

Arthritis hyemalis. Sauv. var. 2.

————— *æstiva.* Sauv. var. 4.

In both these the Bath Waters are exceedingly useful.

* Sulphureous waters taken inwardly are here advised by Sauvage.

PART IV.

2. PRO CAUSA REMOTA.

Arthritis rheumatica. Sauv. sp. 3.

The Bath Waters are likely to be of great use here.

———— *rachialgica.* Sauv. var. 11.

The Bath Waters are of great service in removing or allaying this symptom*.

3. VARIAT. COMPLICATA.

Arthritis chlorotica. Sauv. var. 5.

Bath Waters are of great service here.

———— *melancholica.* Sauv. var. 6.

———— *scorbutica.* Sauv. var. 7.

In both these Bath Waters are likely to be of great service.

Arthritis asthmatica. Sauv. var. 9.

I should think the Bath Waters likely to succeed here.

GENUS XXXVIII.

MENORRHAGIA.

2. SEROSA.

Leucorrhœa. Sauv.

In cases of this kind proceeding from laxity without any local affection, the Bath Waters are frequently successful.

* *Aquæ thermales sulphuræ suadentur.* Sauvage.

ORDO V.

PART IV.

PROFLUVIA.

GENUS XXXIX.

DYSENTERIA.

2. SYMPTOMATICÆ.

Dysenteria scorbutica *. Sauv. sp. 18.

The Bath Waters seem likely to be of great service here,

CLASSIS II.

NEUROSES.

ORDO I.

COMATA.

GENUS XL.

APOPLEXIA.

IDIOPATHICÆ.

1. CAUSIS INTERNIS.

Apoplexia pituitosa. Sauv. sp. 7.

Bath Waters are often of great service in removing the effects of this disorder*.

* Sauvage advises here the use of sulphureous waters.

† Thermal waters are recommended by Sauvage for the same purpose.

PART IV.

Lethargus literatorum. Sauv. sp. 7.

The Bath Waters promise to be of great service here.

GENUS XLI.

PARALYSIS.

I. IDIOPATHICÆ.

Hemiplegia ex Apoplexia. Sauv. sp. 7.

In this the Bath Waters are often very serviceable.

Paralysis serosa. Sauv. sp. 12.

The Bath Waters are here very proper,

Hemiplegia saturnina. Sauv. sp. 14.

The Bath Waters are here of the utmost service.

Paralysis metallariorum. Sauv. sp. 22.*Tremor metallurgorum.* Sauv. sp. 5.

In both these, which seem to be near a-kin, the Bath Waters are frequently of great service.

II. SYMPTOMATICÆ.

Paralysis rheumatica *. Sauv. sp. 3.

The Bath Waters are of great service here.

* Sauvage advises sulphureous waters here.

Paralyfis rachialgica. Sauv. sp. 2.

The Bath Waters are of signal use here, especially if proceeding from lead.

Paraplegia rachialgica. Sauv. sp. 5.

I doubt not that the Bath Waters would be of great service in this species, as well as the foregoing.

Paralyfis biliosa. Sauv. sp. 9.

After proper evacuations the Bath Waters are of great service in this complaint.

Paralyfis scrophulosa. Sauv. sp. 5.

——— *scorbutica.* Sauv. sp. 6.

I should think the Bath Waters likely to succeed here.

Hemiplegia scrophulosa. Sauv. sp. 4.

This seems a-kin to the foregoing, and proper for a trial of the Bath Waters.

ORDO II.

ADYNAMIÆ.

GENUS XLIII.

DYSPEPSIA.

I. IDI-

PART IV.

I. IDIOPATHICÆ.

Cardialgia bradypepta. Sauv. sp. 9.

The Bath Waters are of great service in this species when owing to weakness, proceeding from fevers, living on a moist and cool diet, or the abuse of fermented liquors. When native or hereditary, the Bath Waters often fail.

Anorexia pituitosa. Sauv. sp. 2.

I should think the Bath Waters likely to be of great service here.

Vomitus pituitosus. Sauv. sp. 26.

I should think this species suited to the Bath Waters.

Nausea ex cacochylia. Sauv. sp. 11.

I should think this likely to be relieved by Bath Waters.

Cardialgia flatulenta. Sauv. sp. 3.

Very proper for a trial of the Bath Water.

Gastrodynia flatulenta. Sauv. sp. 2.

This is well suited to the Bath Waters likewise.

Flatu-

Flatulentia acida. Sauv. sp. 1.

——— *nidorosa.* Sauv. sp. 2.

Both these are adapted to the Bath Waters.

Anorexia paralytica. Sauv. sp. 1.

When this proceeds from the inordinate use of fermented liquors, the Bath Waters are very proper.

Gastrodynia atterens. Sauv. sp. 10.

I should imagine the Bath Waters likely to be serviceable.

II. SYMPTOMATICÆ.

I. A MORBO IPSIUS VENTRICULI.

Anorexia biliosa. Sauv. sp. 6.

This species is undoubtedly suited to the Bath Waters.

Gastrodynia biliosa. Sauv. sp. 3.

This species appears to be well suited to a trial of the Bath Waters.

PART IV. 2. A MORBO ALIARUM PARTIUM
VEL TOTIUS CORPORIS.

Vomitus ab hepate obstructo. Sauv. sp. 16.

This is very likely to be relieved by the Bath Waters *.

Gastrodynia hypochondriaca. Sauv. sp. 16.

I should imagine this suited to the Bath Waters.

Gastrodynia chlorotica. Sauv. sp. 15.

This is certainly suited to the use of the Bath Waters.

Anorexia arthritica. Sauv. sp. 12.

This symptom is much relieved by the Bath Waters.

GENUS XLIV.

HYPPOCHONDRIASIS.

I. IDIOPATHICÆ.

Hypochondriasis melancholica. Sauv. sp. 3.

Bath Waters may certainly be often of great service here,

* Sauvage advises the use of thermal waters in this complaint.

Hypochondriasis pituitosa. Sauv. sp. 4. PART IV.

This is certainly suited to a trial of
Bath Waters*.

2. SYMPTOMATICÆ.

Hypochondriasis hysterica. Sauv. sp. 5.

This seems adapted to the Bath Waters.

GENUS XLV.

CHLOROSIS.

I. VERÆ.

Chlorosis virginea. Sauv. sp. 1.

This seems well suited to the Bath Waters.

I. SPURIÆ, seu PALLORES.

Chlorosis rachialgica. Sauv. sp. 12.

This seems likely to be relieved by Bath Waters.

ORDO III.

SPASMI.

SECT. I.

IN FUNCTIONIBUS NATURALIBUS.

* Sauvage advises the use of sulphureous waters.

PART IV.

GENUS XLVI.

TETANUS.

I. IDIOPATHICÆ.

Tetanus tonicus. Sauv. sp. 1.

——— *emprostonicus.* Sauv. sp. 2.

——— *opisthotonicus.* Sauv. 3.

——— *holotonicus.* Sauv. sp. 4.

These disorders seldom appear here, but from the account of them I should think them likely to be relieved by the Bath Waters.

GENUS XLVIII.

CONVULSIO.

IDIOPATHICÆ.

Scelotyrbe chorea viti. Sauv. sp. 1.

This I have seen relieved by the Bath Waters.

GENUS L.

EPILEPSIA.

2. SYMPTOMATICÆ.

Epilepsia cachectica. Sauv. sp. 2.

——— *stomachica.* Sauv. sp. 3.

Both these are proper for a trial of the Bath Waters.

Epi-

Epilepsia uterina. Sauv. sp. 4.

PART IV.

This is also adapted for a trial of the Bath Waters, especially when proceeding from a retention of the menstrual evacuation,

GENUS LII.

ASTHMA.

I. IDIOPATHICÆ.

Asthma humidum. Sauv. sp. 1.

The Bath Waters are often of great use in the intervals of the paroxysms in preventing their return*.

Asthma stomachicum. Sauv. sp. 8.

This is near a-kin to the foregoing, and likely to be relieved by the Bath Waters.

Asthma hypochondriacum. Sauv. sp. 4.

This seems likely to be relieved by Bath Waters†.

* The Bath Waters are especially mentioned by Mr. Sauvage as sometimes of service in the intervals of this disorder.

† Thermal waters are advised here by Sauvage.

PART IV.

2. SYMPTOMATICÆ.

Asthma arthriticum. Sauv. sp. 5.

Bath Waters relieve this symptom often very remarkably*.

GENUS LV.

COLICA.

Colica flatulenta. Sauv. sp. 1.

—— *spasmodica.* Sauv. sp. 7.

After due evacuations the Bath Waters are of great service in both the above-mentioned disorders.

Rachialgia piétonum. Sauv. sp. 3.

The Bath Waters are here the best remedy, especially if the disorder be connected with the jaundice.

Rachialgia metallica. Sauv. sp. 3.

This is very well adapted to the Bath Waters, especially if it be owing to the effects of lead or mercury.

Rachialgia arthritica. Sauv. sp. 4.

—— *scorbutica.* Sauv. sp. 6.

In both these the Bath Waters are likely to be very serviceable.

* Sauvage advises the use of hot springs here.

GENUS LVI.

PART IV.

CHOLERA.

Cholera arthritica. Sauv. sp. 10.

In this the Bath Waters are the best remedy.

GENUS LVII.

DIARRHOEA.

I. IDIOPATHICÆ.

Diarrhœa vulgaris. Sauv. sp. 2.

This may be proper for a trial of the Bath Waters.

Diarrhœa ab hypercatharsi. Sauv. sp. 16.

This is frequently cured by the Bath Waters.

Diarrhœa arthritica. Sauv. sp. 9.

Bath Waters are the best remedy here.

GENUS LVIII.

DIABETES.

I. IDIOPATHICÆ.

Diabetes a vino. Sauv. sp. 5.

This is often much relieved by the Bath Waters.

PART IV.

2. SYMPTOMATICÆ.

Diabetes hystericus. Sauv. sp. 3.

I should think the Bath Waters likely to be of service here.

Diabetes arthriticus. Sauv. sp. 6.

Bath Waters often relieve this symptom.

GENUS LIX.

HYSTERIA.

I. IDIOPATHICÆ.

Hysteria chlorotica. Sauv. sp. 2.

Bath Waters are extremely proper in this species, especially when accompanied with a retention of the menstrual discharge*.

Hysteria a menorrhagia. Sauv. sp. 3.

Bath Waters must certainly be proper here.

Hysteria a leucorrhœa. Sauv. sp. 4.

Bath Waters are proper here.

* Warm sulphureous waters are advised by Sauvage to be drank for this complaint.

I. SYMPTOMATICÆ.

PART IV.

Hysteria stomachica. Sauv. sp. 7.

The Bath Waters, cautiously used, may be here of great service.

Hysteria emphaëtica. Sauv. sp. 5.

In this the Bath Waters are eminently serviceable.

C L A S S I S III.

C A C H E X I Æ.

O R D O I.

M A R C O R E S.

G E N U S LXVI.

A T R O P H I A.

Atrophia nervosa. Sauv. sp. 1.

The Bath Waters, when used in the beginning of this complaint, are of great service.

Atrophia ab alvi fluxu. Sauv. sp. 6.

The Bath Waters, if used before the bowels are excoriated, or much irritated, are of great use,

Atrophia a leucorrhœa. Sauv. sp. 4.

The Bath Waters are very proper here.

PART IV.

ORDO II.

INTUMESCENTIÆ.

SECT. II.

FLATUOSÆ.

GENUS LXVIII.

PNEUMATOSIS.

Emphysema spontaneum. Sauv. sp. 1.

This is often relieved much by Bath Waters.

Pneumatosis hysterica. Sauv. sp. 3.

The Bath Waters are likely to be serviceable here.

GENUS LXIX.

TYMPANITES.

Tympanites intestinalis. Sauv. sp. 1.

Bath Waters are of the greatest service here*.

Tympanites enterophyodes. Sauv. sp. 2.

Much of the same nature with the foregoing, and probably adapted for a trial of the Bath Waters.

* Thermal waters are recommended by Sauvage.

SECT. III.

PART IV.

AQUOSÆ, five HYDROPEs.

GENUS LXXI.

ANASARCA.

Pblegmatis vulgaris. Sauv. sp. 1.

The Bath Waters are undoubtedly of the greatest service here, if used early in the complaint.

Anasarca a fluxu. Sauv. sp. 2.

Bath Waters are here particularly serviceable.

Anasarca a febribus. Sauv. sp. 4.

This is generally much relieved by the Bath Waters.

Anasarca metastatica. Sauv. sp. 1.

In both the varieties of this species, viz. the periodica and ab adiapneustia, the Bath Waters are likely to be of great service.

Pblegmatis a menostasiâ. Sauv. sp. 5.

Bath Waters are here very useful.

Anasarca rachialgica. Sauv. sp. 8.

This is relieved by the Bath Waters.

PART IV.

GENUS LXXV.

ASCITES.

I. SEROSI ABDOMINALES.

Ascites ab oppilatione. Sauv. sp. 2.

—— *ab hepate.* Sauv. sp. 3.

—— *a liene.* Sauv. sp. 4.

The Bath Waters are of infinite service in all these, provided the disorder be recent, and no actual inflammation be present, or scirrhus formed.

Ascites a sanguifluxibus. Sauv. sp. 7.

The Bath Waters are of great service here, provided there be no danger of inducing a fresh hæmorrhage.

Ascites febrilis. Sauv. sp. 12.

a. —— *ex quartanâ.*

Bath Waters have been very serviceable in cases of this kind.

Ascites arthriticus. Sauv. sp. 9.

The Bath Waters are very proper here.

Ascites scorbuticus. Sauv. sp. 11.

Bath Waters are of great use here.

GENUS

GENUS LXXIX.

PART IV.

RACHITIS.

Rachitis Britannica. Sauv. sp. 2.

Bath Waters may be used with great advantage in many instances of disorders of this kind.

ORDO III.

IMPETIGINES.

GENUS LXXX.

SCROPHULA.

Scrophula vulgaris. Sauv. sp. 1.

The Bath Waters have been found of great service in this complaint, when used before it be too far advanced.

GENUS LXXXIII.

ELEPHANTIASIS.

Elephantiasis legitima. Sauv. sp. 2.

I should imagine the Bath Waters likely to succeed here.

GENUS LXXXIV.

LEPRA.

Lepa Græcorum. Sauv. sp. 1.

——— *Indica.* Sauv. sp. 3.

In both these the Bath Waters are extremely serviceable.

GENUS

PART IV.

GENUS LXXXVII.

ICTERUS.

Aurigo rachialgica. Sauv. sp. 14.

This symptom is certainly proper for a trial of the Bath Waters.

Aurigo ab obstructione. Sauv. sp. 6.

When no inflammation or fever, or pain of the liver, is present, the Bath Waters are the best remedy*.

Aurigo accidentalis. Sauv. sp. 2.

Bath Waters prove here the quickest remedy.

CLASSIS IV.

LOCALES.

ORDO II.

DYSCINESIÆ.

GENUS CI.

CONTRACTURA.

I should imagine the Bath Waters likely to be of service in the species of this genus.

* Sauvage advises thermal waters.

ORDO IV.

PART IV.

EPISCHESES.

GENUS CVII.

OBSTIPATIO.

When this proceeds from weakness, or want of sensibility in the bowels, the Bath Waters give great relief.

CHAPTER II.

HAVING finished what I had to say PART IV. on the medical qualities of the Bath Waters, I now proceed to the second Chapter of this Part, which I propose shall comprehend my sentiments on the methods by which the waters may be best managed, so as to fulfil, most successfully, the above-mentioned indications in the cure of diseases. This, which, in some respects, may be called the Pharmaceutical Part, I intend to pursue in the order cited at the beginning of the foregoing Chapter. The first consideration that here occurs is relative

1. To our Choice of the Waters.

I have

PART IV. I have before mentioned the Bath Waters in general, as possessing the qualities of stimulant, astringent, diuretic, diaphoretic, antispasmodic, and antiseptic.

That the qualities of stimulant, astringent, and antiseptic, were possessed in the highest degree by the King's Bath Water, those of antispasmodic and diaphoretic by the Hot Bath, and that of diuretic (though of this I am not certain) by the Cross Bath Water.

In consequence of this it appears, that where the stimulant, astringent, or antiseptic qualities of the waters are desired to exert their effects, that there the King's Bath Water must be most adviseable; where such a degree of stimulus or astringency would be injurious or improper, and the diaphoretic and antispasmodic effects were more peculiarly to be promoted, there the Hot Bath Waters would be more efficacious; and where a still less degree of stimulus was proper, and a large quantity of fluid adviseable to be taken in, and the urinary evacuation more particularly promoted, there the Cross Bath might be preferable to either of the others.

The

The particular disorders for which each water is peculiarly adapted, will be found under the respective articles of their qualities, in the former Chapter of this part of the work. PART IV.

Thus, in general, all the disorders to which the stimulant, astringent, and antiseptic qualities of the waters are there mentioned, as conducive to their cure, will be most proper for a trial of the King's Bath Water: Those for which their diaphoretic and antispasmodic qualities are recommended will more properly make use of the Hot Bath Water: And where large dilution is required, as in some glandular cases, and the urinary secretion to be promoted, there the Cross Bath would be most adviseable.

But I would have it here understood, that I am far from meaning to assert, that any directions of this kind should be indiscriminately observed. Though I believe the effects of the Bath Waters on the generality of constitutions to be as I have described them, I am, at the same time, fully satisfied, that these effects are very much varied by custom and peculiarity of constitution.

PART IV. constitution, and, probably, other causes with which we are unacquainted. I have seen several instances where the Hot Bath proved more stimulant than the King's, and I have been informed, from good authority, that it is not very uncommon for the Cross Bath Water to prove more heating than either of the others.

These circumstances point out an useful maxim in practice, not to determine precipitately in many disorders, (whose symptoms do not immediately forbid their use altogether) that the Bath Waters will be of no service, until we have given each of the springs a fair trial, since they frequently have their effects so much varied in peculiar habits and constitutions.

The next question that occurs in order, is relative to

2. The state in which the waters, when drank, possess their medicinal qualities in the greatest degree.

When we consider the nature of the substances with which these waters are impregnated, there can remain little doubt with regard to the determination of this question.

question. The fixible air, which perhaps PART IV.
is the most important substance that enters
into its composition, is of so fugitive a na-
ture, as to be in a great measure dissipated
soon after its exposure to the atmosphere.
The chalybeate impregnation, likewise,
whether from its peculiar nature and quali-
ties, or lightness, is very soon destroyed, the
water giving scarce any signs of it, except
examined soon after its rise. In all cases,
therefore, where the effects of the water,
particularly the stimulant and astringent,
are desired in their full extent, the wa-
ters are, undoubtedly, in greatest per-
fection drank at the fountain head. Many
cases, however, may be supposed, wherein
the use of the waters may be in some re-
spects adviseable, yet their stimulant quali-
ties may prove too violent a shock for a
tender frame to endure. In such cases,
by suffering it to stand a minute or two
after it has been drawn, the substance on
which this quality principally depends will
be in a great measure dissipated, and their
stimulus much abated.

It is probable, that their good effects in
leprous and other cutaneous disorders, do
not

PART IV. not depend so much on the stimulant, as on the diaphoretic and diuretic qualities, which are more permanent. In these cases, then, it might be adviseable not to drink the waters at the pump, but more at leisure, in private, when their heat, on which their stimulus in some degree depends, was abated. By this means we might be enabled to take them in much larger quantity than we otherwise could, a circumstance of great moment in these disorders, where large dilution, and as it were washing out the lymphatic system, is of so much consequence. Care should be taken, nevertheless, that the water should not be suffered to stand so long as to cause any precipitation, as this would altogether alter its nature. In all cases, however, where the Bath Waters are meant to act as restoratives, and of consequence their stimulus, in some degree at least, must be of service, I would always advise them to be drank fresh at the spring, and to moderate their effects, if too powerful, rather by lessening the quantity, than using them when deprived of some of their serviceable qualities.

The subject now before us naturally leads to another question, viz. How these waters

waters bear transportation, or, in other words, what alteration of their qualities is produced by standing. In order to explain this more effectually, it will be necessary to make a short recapitulation of the phænomena that appear in these circumstances. PART IV.

It appears by Experiments, that the Bath Water newly pumped emits a large quantity of air bubbles, which are plentifully evolved from every part of it, and that this impregnation is so volatile, that it can scarcely be carried any distance without losing, in a great degree, that sparkling appearance and pungent taste so remarkable in it when fresh. Its chalybeate taste and qualities are then much diminished, and on remaining a little time exposed to the air entirely cease.

On cooling, the saline taste, and that of the hep. sulph. cum calce viva, become much more remarkable, and, indeed, some alteration seems to take place in the last mentioned impregnation, as the water then gives a green tinge to the vegetable blues. If exposed to the air it soon assumes a wheyish turbid appearance, and lets fall a

D d

light

PART IV. light ash-coloured precipitate; and the latter happens in some degree even in close vessels, though the change of colour is not so remarkable. From these appearances I am induced to believe, that the common opinion that the Bath Water loses most of its valuable qualities on standing, is not ill founded.

The fixed air and chalybeate impregnations are, undoubtedly, destroyed, and the hep. sulph. c. calce viva seems to undergo a decomposition of its parts. A circumstance happens here that is far from being common in waters of this kind. Most of those that contain fixed air, along with a chalybeate impregnation, bear transportation very well, and, when carefully closed up at the spring, may be carried to any distance, with scarce any diminution of their valuable qualities. The Bath Waters, however, which contain both these impregnations, and the former of them in very large proportion, although the bottles containing it be closed up with the greatest accuracy, as soon as filled from the spring, on their being again opened, give very little marks of the chalybeate impregnation,

tion, and scarce any of the aërial one. PART IV.
This alteration seems remarkable, as we cannot suppose it possible for the fixed air to have escaped, especially as we see it retained in like circumstances in many other waters. The cause of this, however, seems as if it might be explained as follows :

All the preparations by which sulphur is rendered miscible with water, both by means of an alkali and quick lime, are, in some degree, decomposed on such admixture, and the latter more easily than the former. As we have the utmost reason to believe that the last mentioned combination makes a part of the impregnation of the Bath Waters, it is probable that such a decomposition takes place here, the quick lime and the sulphur separating from one another. In that case the quick lime, whose strong affinity with fixed air has been before taken notice of, being now at liberty, attracts that contained in the water, and is thus rendered soluble, and makes part of the precipitation observed to be formed in the Bath Water on standing. This accounts for the sparkling appearance and pungent taste not being observed

PART IV. in the bottles containing the water being again opened, as the mephitic air is then in a fixed state, and strongly united with the lime. By this it should seem, that the Bath Waters can serve very few useful purposes in medicine, when used at a distance from the spring, their impregnation with fixed air being thus destroyed, and the chalybeate and sulphureous ones nearly so. Some small impregnation of the last mentioned kind may indeed remain, as even mild calcareous earths render sulphur in some degree miscible with water, but then this proportion of it is extremely small.

I can, therefore, say very little in recommendation of their use at a distance from the spring, as they seem to be then little more than simple water impregnated with a large portion of selenites, and a small one of common salt, which certainly are not impregnations likely to serve many useful purposes in medicine.

The next consideration that occurs is relative to the

3. Quantity in which the Bath Waters ought to be taken.

Nothing

Nothing can be laid down with precision relative to this point, as it is obvious that it must vary greatly according to circumstances. Our first and principal direction, in this case, must be drawn from the indication we desire to promote, though the age, constitution, time of the year, and peculiarity of disposition of the patient, and the state in which the water itself is drank, and our choice of it, the last especially, must be likewise considered.

By the old accounts it appears, that these waters were taken formerly in much larger quantity than is ever ventured on in the present practice. *Guidott mentions three pints a day, as the smallest quantity commonly taken, and goes so far as to recommend, in some cases, even ten pints a day to be swallowed. But since his time, and of late years especially, the dose has been much diminished, and the quantity which he advised as the smallest, is now scarce ever exceeded, by advice of the Physician, even in those cases where the greatest quantity is thought necessary.

* P. 265, 266.

PART IV.

I am apt to think, that if the old practitioners have been mistaken in advising them in so large quantity, that the moderns, on the other hand, have sometimes disappointed their effects, by too great limitation, as I am well satisfied that the waters may, with the utmost safety, in general, be taken in considerably larger quantities than those commonly exhibited at present.

I believe the modern practice scarce ever exceeds three pints in twenty-four hours, and in general half, or at most two-thirds of that quantity, are judged sufficient. To me it appears, that in cases wherein the stimulant or astringent qualities of the waters were desired, and where the Hot or King's Bath Waters, the last especially, were recommended, and drank immediately after being drawn there, a moderate quantity would be proper, as their stimulus would then exert its full force, and be as much concentrated as possible, which must limit considerably the quantity taken in. These reasons will hold stronger if the patient be young, or of an irritable habit or constitution, or make a trial of the waters at a time of year favourable to inflammatory complaints. Add to this, that a large
bulk

bulk of any medicine is peculiarly disagreeable to those whose stomachs have their tone injured, as is the case with many who apply to these waters for relief. PART IV.

I have before mentioned, that it is not possible to lay down any rule for this that will not be liable to many exceptions, but in general I should think *, that the waters, when exhibited in these intentions, might be properly taken, by a grown-up person, from two-thirds of a pint to two pints in a day, but not to exceed the last mentioned quantity.

In cases where the diuretic, diaphoretic, or antispasmodic qualities of the waters are desired, or where the patient is advanced in life, of an inert habit, and makes use of them at a moderate season of the year, especially if the Cross Bath, or even the Hot Bath Water be used, some more latitude may be allowed; though I confess, in this case, I would not advise to go beyond from one pint to two pints and a half, or three pints in twenty-four hours. But in cases where the waters are used as di-

* I here mean the Hot or King's Bath Water, the last especially, as generally given with this intention.

PART IV. luents, and for washing out the lymphatic system, as in many glandular and cutaneous disorders, where the patient is not likely, from age, or disposition, to have an inflammatory complaint excited in him, when the season is moderate, and the less stimulant water, as that of the Cross Bath, or even the Hot Bath, made use of, and that not drank until some of its stimulant qualities had evaporated; in these circumstances, I say, a still greater latitude may be permitted, and the water safely drank from one to three quarts, or even more in a day, though I should not often advise to exceed that quantity. In general, as we can determine but imperfectly *a priori*, what will be the effect of the waters on any constitution, since this is so frequently varied from peculiarity of disposition, and other causes, it is always safest and best to begin with small quantities, as half a pint, or two-thirds of a pint in a day, which may afterwards be easily increased to any quantity that may be thought proper. I think I have seen much mischief done, both in the present effects and future consequences, by patients imprudently beginning with too large doses of the waters,
not

not only an inflammatory complaint being excited, but the stomach, from having been overloaded, acquiring such a distaste to them, as to prevent a trial of their effects afterwards in cases apparently suited to their use. PART IV.

It is likewise an useful caution, even in many cases where their stimulus, in some degree, is desirable, but where their inflammatory effects are apprehended, to divide the quantity to be taken in a day into a number of small doses, to be taken at moderate intervals, by which their stimulus becomes less sensible and more permanent.

This is found to be the case, even though the quantity taken in this manner should, on the whole, exceed the other. Thus one pint drank at once has more effect in raising the pulse, and heating the body, than three half pints drank with an hour's interval between each.

The next circumstance of which I shall speak is concerning the

4. Time of the day at which the waters are most properly exhibited.

On

PART IV.

On this I have little new or particular to offer. The general custom has hitherto been, to drink the whole of the water advised to be taken before dinner, viz. two-thirds of it before breakfast, between the hours of eight and ten, and one-third at noon. I am inclined also to believe that the above method is very proper on many accounts, especially when the waters are used as stimulants, antispasmodics, astringents, or diuretics. By being thus taken a moderate time before meals they excite appetite, and promote the digestion of food very powerfully. Some are advised to repeat them again in the interval between dinner and supper, but except a very moderate dinner has been taken, I do not approve much of this method in general. But as the effects of the waters vary so much from peculiarity of habit, I will not deny, that in some cases of this kind they may be employed in this way with advantage. I have likewise seen exceeding good effects from a glass of the water drank at going to bed, and I think it always advisable to make a trial of them in this manner, when we are particularly desirous of promoting the diaphoretic secretion. A
glass

glass of the water drank at going to bed is likewise often very efficacious in promoting sleep, which it seems to induce by its antispasmodic quality. When the Hot or Cross Baths are used as diluents, as in glandular cases, and drank at home, or after the stimulant qualities of the water have in some degree abated, cautions of this kind are less necessary, and the water may be taken in such manner as shall be found by experience most agreeable and convenient.

The next question that occurs is,

5. What season of the year is best adapted to their use?

Formerly the use of the Bath Waters was confined almost altogether to the summer months, but since that time the colder seasons have been preferred, though extremes of both kinds have always, I believe, been reckoned in some degree to contraindicate their use. I confess it to be my opinion, that we are in general more likely to find their good effects in a warm, than a cool season, especially in cases where their stimulant and diaphoretic qualities are likely to be serviceable. Thus I have observed

PART IV. observed paralytic cases more relieved by their use, during a short course of warm weather, than by a much longer trial of them during a cold season. Indeed, in many cases of this kind, the weather can scarce be so hot as to render it necessary to forbid their use, except we actually observe some inconvenience attending it. The same is true, in some degree, when we use them as diaphoretics, to restore the perspiratory discharge, as in many cases where this discharge is interrupted, on changing from a warm to a cold climate, and dropsy and obstructions of the viscera are consequent thereon. In cases where the Bath Waters are meant to act as restoratives in debilitated habits, in which their astringent and antispasmodic effects, joined to a moderate degree of stimulus, would be desirable, a more moderate season would be advisable, as they would not then be either so apt to heat by their stimulus, or weaken by increase of the secretions. A priori, we might perhaps imagine that their diuretic qualities would be greatest in cold weather; but I find the contrary, by experience. A season rather cool than warm to the senses, undoubtedly tends to promote

promote the passage of the waters in this manner; but I find, that when the temperature of the air falls so low as to thirty-two degrees, that this quality becomes much more uncertain than in more moderate seasons. I think I have seen the Bath Waters in * very cold weather prove cathartic from that cause. In general, my opinion is, that the Bath Waters, when desired to act as stimulant, as in low weak cases, especially of the paralytic kind, are in greatest perfection in the warmest seasons, as in the latter part of June, July, and the beginning of August; when a moderate degree of stimulus was required, and their diaphoretic effects desired to be promoted, the latter part of May, and beginning of June, and from the latter part of August, to the end of September, are more proper; and where we use them with an intent to promote the urinary evacuation, as mild diuretics, as in gravelly complaints and urinary obstructions, there the months of March, April, and beginning of May, and the month of September, and beginning of October, would be preferable.

* Diuretic and diaphoretic medicines, as the saline draught and nitre, often prove cathartic in very cold weather.

PART IV. I beg here to be understood to mean only, that the waters are most likely to produce the above mentioned effects at the seasons there set down, not to forbid their use at other seasons, even though they should be then used to promote an intention to which the season is not adapted.

The effects of the waters are so modified by custom and peculiarity of constitution, and other accidental circumstances, as not to admit of any determinate rule to be laid down concerning them. Thus I have seen them prove diuretic in a warm, and diaphoretic in a cold season; and I am inclined to think, on the whole, that when they are indicated in the habit and constitution, that no season of the year whatever ought absolutely to forbid a cautious trial of them, since more would be, probably, lost by the delay, than gained by trying them only at a time when they might be most likely to prove efficacious. Formerly great stress was laid on the time of year at which the waters themselves were in greatest perfection; but as far as we are able to judge, the qualities of the waters remain the same at all of these, as the origin

gin of the springs probably lies too deep to be affected by rains, frost, heat, or other changes of the atmosphere. PART IV.

The next question which I shall enter upon is,

6. What length of time it is proper to continue the use of the Bath Waters.

This question, as well as the foregoing, can be treated only on general principles.

In order to judge of this properly, several things must be taken into consideration, as the choice of the waters, their state when drank, the quantity and season of the year, and constitution of the patient, but still we must principally attend to the indication we desire to promote. When used with a stimulant or astringent intention, we ought, undoubtedly, to attend to the general cautions relative to the use of stimulants, which in this case affects their astringent quality likewise, as that depends, in a great degree, on their stimulus. It is observed of all disorders that require the use of stimulants, that at first we reap great benefit from them, but that their good effects are destroyed by habit.

This

PART IV.

This should caution those who frequent this place not to get into a custom of drinking the waters frequently, except their health required it, since by that means they would be likely to disappoint their effect when they might be desired. This observation, though not holding true so particularly of the Bath Waters as of the stimulant substances commonly used in medicine, yet is still, in some degree, applicable to them. Hence then, when it is in our power, we ought to interrupt their exhibition in order to interrupt the habit by which their effects are lost. This holds stronger if the more stimulant water be used, if it be drank fresh from the spring in large quantity, and at a season of the year likely to produce inflammatory disorders.

The use of them in this manner seems pointed out by nature, since the waters, though at first highly grateful to the stomach and taste, by long use become disagreeable, and sometimes in so great a degree as to excite vomiting, and when thus long continued I have several times observed, that all the advantage before gained was destroyed for that period. In general, the course of drinking the waters, when exhibited

exhibited with these intentions, is from PART IV. three weeks to two months.

When given with a diaphoretic, antispasmodic, or antiseptic intention, and when the less stimulant waters are used, as the Hot and Cross Baths, and where the season is moderate, and the constitution not disposed to inflammatory complaints, greater latitude may be admitted of. In general I think that the waters, when given in this manner, may be continued from six weeks to three months, though even in this case it is often found advantageous to intermit their use for a short time, now and then, to prevent the nausea, which their long continuance is so apt to induce on the stomach.

When the Bath Waters are given as diluents in glandular disorders, for the purpose of washing out the lymphatic system, and as gentle diuretics, to clear the urinary passages in slight gravelly complaints, a longer time still may be allowed, and the waters may, in this case, be often drank with advantage, from two to six months, especially if the Hot or Cross Bath Waters be used, and not drank till some part of their

E c

volatile

PART IV. volatile impregnation has evaporated. But though I mention them as proper to be continued longer in these cases than any others, yet even here it will be often advantageous to intermit their use for a short interval, now and then, in order to prevent them becoming disagreeable to the stomach *, which has been before mentioned, as apt to occur from their long continuance.

The next article to which I shall speak, is concerning

7. The regimen of life best adapted to the drinking the Bath Waters.

On this subject I have little new or interesting to offer. Some writers have run out to great lengths in directions of this kind, which, though good in themselves, are not peculiarly adapted to the present purpose, which is not to treat on regimen in general, but only as connected with the use of the Bath Waters.

* Where their long use is necessary, it is often found advantageous to change the water drank for that of one of the other baths, which will frequently obviate this circumstance.

What I have to deliver on the subject PART IV.
may be comprized in a short compass.

As to diet, the indication must be considered, and what suits that best will in general be most proper. Where the waters are intended to act as stimulants, astringents, diaphoretics, or antispasmodics, a moderate diet of the flesh of full grown animals, as mutton and beef, is most proper, with a rather small proportion of fresh vegetables, of which the roots and seeds are preferable to the leaves and stalks, and a large proportion of bread. When used as antiseptics, or diuretics, as in scorbutic and cutaneous disorders, the proportion of meat in the diet should be lessened, and that of vegetables increased; and here I should think that the acrid plants, such as those of the filiquose tribe, and other antiscorbutics, might be advantageously used in food. How an entire milk and vegetable diet would agree with the use of the Bath Waters I never had an opportunity of observing.

One caution, however, is necessary, which is, to be very careful of indulging the appetite to its full extent, when it is sud-

PART IV. denly increased, or restored, by the use of the Bath Waters. I have several times had occasion to observe, that in these cases the appetite was increased beyond the powers of digestion, and on that account required to be restrained. As to drink, I have little more to recommend than moderation, in the use of fermented liquors, which is a caution particularly to be attended to, as, by excess of that kind, the advantage to be gained by the use of the waters is not only disappointed, but great danger incurred of inducing a fever, or apoplexy, since these waters have their stimulant qualities greatly increased, when an over proportion of fermented liquor is taken during their use. As to choice of liquors, I know no general rule that is applicable. I have seen the Bath Waters agree equally well, when water alone, malt liquor, or wine, and rum or brandy diluted with water, have been taken during their use. How far any of these liquors may be more properly taken in the different disorders, is another consideration, and not immediately connected with the present subject, and concerning which no certain rules can be laid down. In general, it has been thought,

thought, as costiveness is so common an effect of the Bath Waters, that red wines in general were improper, as tending to increase that disposition, which frequently is very troublesome. If this effect of the waters is actually discovered to be increased by the use of red wine, it is, undoubtedly, proper to change the liquor; but, in my opinion, this effect is too uncertain to render it necessary to recommend, a priori, any change of this kind to those with whom red wines are found to agree in other respects.

Another circumstance of great importance, and particularly connected with the use of the Bath Waters, is exercise.

This, in a moderate degree, in cases where it is practicable, is especially necessary during the use of the Bath Waters, in order to second their effects, in strengthening the organs of digestion, and increasing the diuretic and diaphoretic secretions, which are the best means of their passing off. I believe that the method commonly practised in this way is extremely proper, viz. a gentle walk early in the morning, between the intervals of

PART IV. drinking the waters, which encourages the diuretic evacuation, and moderate horse exercise at noon, to keep up the perspiratory discharge. In short, the necessity of exercise is so great in this case, that, unless it can be used in some way or other during a course of the waters, they are seldom of much service. Good hours, likewise, are especially necessary on many accounts, and particularly as the waters are in general found to succeed best when drank early in the morning at the spring head. Repose of mind, and freedom from intense thought, are likewise highly advantageous, as close study and application not only counteract the effects of the waters, by their known effects in injuring digestion, but likewise, in general, prevent such a degree of exercise as is necessary during the use of the waters.

I now come to the last head, concerning which I shall treat, viz.

8. Of the medicinal substances proper to be taken along with, or during the use of, the Bath Waters.

These may be considered in two lights, viz. those which are given to second, or correct

correct the effects of the waters, and those which may be taken on other accounts during the time of drinking them, but which are not otherwise immediately connected with their use. PART IV.

I shall first speak a few words with regard to those medicines that may be given with the first of these intentions, viz. with the intention of seconding their effects. In order to judge of these properly, we must consider the indication we desire to promote.

In cases where their stimulant effects alone are desired, without any view to the increase of any particular evacuation, I think very little more can be done to second their effects than to reconcile them to the taste, and enable the stomach to retain them, since we meet with few of this kind with whom the common stimulants (of the spirituous kind especially) have not been already tried without effect, and a great number, where an indulgence of this kind has been the principal cause of the disorder, for the cure of which they come to make trial of these waters.

In general, the waters are found highly grateful, and agreeable to the stomach, in cases of this kind ; but we sometimes meet

PART IV. with instances where they are nauseated, and even rejected, either from idiosyncrasy, or from the bulk of the dose offending the stomach, or from its being diffused to a liquor that does not contain some spirituous ingredient. What is most likely to obviate this effect of them I shall speak presently, when I come to treat of the substances to be used, with a view towards correcting their qualities.

When we desire to increase the astringency of the waters, an addition to their chalybeate impregnation seems to be the means whereby it may be done with least change induced on their qualities. If we mean to be scrupulously exact, we may here make use of a small quantity of solution * of iron filings in the water of the particular Bath which is directed to be used, added to each glass, which will impart an additional chalybeate impregnation, of a similar kind to that which originally existed in the waters. But I am inclined to think this more nice than necessary, and find, by experience, that a few drops of

* If this be used, it should be previously made, by putting the filings into a bottle, and filling it at the fountain head, and closing it immediately.

either

either of the artificial solutions of the metal, PART IV.
as of a saturated solution of green vitriol
in water, or the tinctura martis c. spiritu falis
added to a glass of the water, answers the
purpose equally well. Where a stronger
degree of astringency is required, I see no
objection to a few grains of alum taken
in the same manner.

Where the mineral astringents disagree,
a trial may be made of the vegetable; but,
I confess, I should not much recommend
them in this case, as being uncertain in
their effect, which must be rendered more
so, by the necessary limitation of their dose
when taken in this manner, and, more-
over, because they change both the colour
and even quality of the waters, in some
degree, by precipitating the chalybeate
part of the impregnation. On these ac-
counts, therefore, I would advise, when
such are necessary, that they should be
taken in the intervals of drinking the wa-
ters, and at the greatest possible distance
of time from each dose.

The diuretic qualities of the waters, as
being generally found, by experience, to be
a favourable means of their passing off,
deserve great attention. In order to pro-
mote

PART IV. mote this, when tardy, the dulcified spirits of nitre and vitriol are commonly used, and in general with good effect. But as the urinary organs are variously affected in different people, it may be of service, in cases where it is proper to encourage this secretion, to make trial of acids and alkalies, both in their turns, and even neutral salts, and to fix on such as may be found most efficacious to fulfil such intention. I would, therefore, where the above-mentioned mineral acids should not produce the effect, advise to try, first, the vegetable acid, as cream of tartar, which I find, by experience, to be a powerful diuretic *. If this should fail, trial may be made of alkaline salts, the mild especially, as lixivium tartari. If this should prove ineffectual, nitre may be tried, whose effects in this way are well known. A judicious Physician will soon discern whether the compound or simple salts are most effectual in the several circumstances.

Next to the urinary secretion, the diaphoretic is generally esteemed to be the

* I have found a draught of common whey, or, what is more efficacious, a whey made with cream of tartar, drank in the intervals of drinking the waters, very efficacious in fulfilling this intention.

most

most happy method of their passing off, PART IV.
and in some cases even more eligible*.

To encourage this, then, in cases where they do not pass off by urine, and in some circumstances in preference to it, must be very desirable sometimes. This defect seems to proceed from the waters proving too heating, and in this case the dulcified spirits of nitre and vitriol, and the neutral salts, will often succeed. When it proceeds from a want of determination to the perspiratory organs, from the increase of any other secretion, a few drops of the * *essentia antimonii*, or a small quantity of antimonial wine, or solution of emetic tartar, with a few drops of *tinctura thebaica*, or a little *elix. paregoric.* taken either with, or, what I would more recommend, an hour before drinking the waters, will sometimes induce this effect of them very powerfully. In disorders of the

* In general, if none of the excretions, as stool, urine, or perspiration, are sensibly increased on drinking the Bath Waters, they are apt to remain a long time on the stomach, impair and pall the appetite, and frequently aggravate the very disorders they were intended to relieve.

† *Essentia antimonii*, *vinum antimoniale*, and a saturated solution of emetic tartar, caused no precipitation with the Bath Water.

cutaneous

PART IV. cutaneous kind (not venereal) where * mercurial medicines are more proper, they may be used with the same intention during the use of the waters.

I am apt to believe, that in some low languid cases, an addition to the chalybeate impregnation would have this effect.

As to their antispasmodic quality, it seems of a peculiar nature, and connected particularly with the bowels. Many medicines may be properly taken with this intention, during the use of the Bath Waters, but I know none that is particularly adapted to coincide with them in this intention.

As to their antiseptic qualities, it is not quite certain that they act by means of them. I should think the best method to second this effect would be by the use of such methods as increase the diuretic discharge.

* Mercurial preparations, such as mercurius dulcis and corrosive sublimate, when added in solution to the Bath Waters, cause a precipitation, and are, probably, decomposed. On this account it would be more proper to use them, when necessary, in the intervals of taking the waters.

I shall

I shall now speak a few words on the substances proper to be used, in order to correct some of the qualities or effects of the waters. PART IV.

And, first, of those which serve to render them agreeable to the palate, or stomach, concerning the necessity of which I have before spoken.

Tincture of cardamoms is, I believe, the most commonly used with this intention, and succeeds very well. If the tinctura aromatica, or tincture of cinnamon *, are more agreeable, they may be used with equal propriety.

I have likewise seen a tincture of columbo root of great service in reconciling the Bath Waters to the stomach. I have also found the acid † and sweet elixirs of vitriol very efficacious in the above intention.

If their stimulant qualities prove too powerful, the dulcified spirits of nitre, or

* The quantity of cinnamon is too small to be inconvenient, on account of its astringency.

† I never made the trial, but should think that the pargoric elixir might be often very properly used on these occasions.

vitriol,

PART IV. vitriol, added in small quantities to the waters, are very effectual in abating their inflammatory effects, and procuring them a discharge by their proper outlets. Nitre, likewise, taken occasionally, either in the waters, or in the intervals of drinking them, is often very serviceable in the same manner,

If their astringency proves troublesome, recourse must be had to some purgative medicine. As to our choice of these we must be governed by the circumstances of the patient. If they have proved merely astringent, without any inflammatory effects, if the patient be advanced in life, and of weak organs of digestion, a few grains of aloes, or rhubarb, with some other stomachic or carminative ingredients, taken occasionally, will be most proper. If, on the other hand, the waters have proved stimulant, if the patient be young, or in the prime of life, with his stomach or digestion unimpaired, and especially if he use the waters on account of any cutaneous complaint, here the saline purgatives, as being cooling, and at the same time promoting the diuretic discharge, which
is

is here of great consequence, may be used, PART IV.
as *sal polychrestum*, Glauber's salt, *sal*
cath. amar. sal diureticus. Soluble tartar,
or Rochelle salt, may be used with equal
propriety, in small quantities, in the in-
tervals during the time of drinking the
waters. I have known nitre, taken in the
waters to have the same effect, but I ima-
gine there are few of those who frequent
this place, whose stomachs would bear it
in quantity sufficient.

The diuretic and diaphoretic effects of
the waters have, it is said, sometimes been
increased to the prejudice of the patient, but
such cases are very few, and owing either
to some idiosyncrasy of the patient, or
else to their being employed in improper
cases, and, probably, the effects of the
disorder itself often mistaken for them.
It may, nevertheless, in many cases be
advantageous to have it in our power to
change the determination of the waters,
or the outlets by which they pass off.
Thus in some cutaneous disorders, owing
to obstructed perspiration, and other com-
plaints owing to the same cause, as habi-
tual laxities, &c. which often happen in
confe-

PART IV. consequence of change of climate, the restoration of perspiration is of great consequence.

But the Bath Waters are not likely to produce this effect, in any great degree, as long as they continue to pass off largely by the urinary secretions. A substance, then, which would determine them to the perspiratory organs, must be of consequence. How this will be best done, will be understood by what I have lately said of those medicines that encourage the diaphoretic qualities of the waters. On the other hand, in cases where the diuretic evacuation is manifestly of service, we might be desirous to have the waters pass off in this manner. This is often the case in slight gravelly complaints, and some cutaneous disorders, as the leprosy, &c. wherein the increase of the urinary evacuation is, undoubtedly, of great service. For this purpose, see what is said of those substances that promote this effect of the waters.

I shall next subjoin some observations on the medicinal substances which may be taken during the use of the Bath Waters, chiefly

chiefly with a view to their chemical qualities. I shall treat this very briefly, in a general manner, as it cannot be expected that I should descant on each particular article.

PART IV.

SALINE SUBSTANCES.

These are improper during the use of the Bath Waters, except taken at a considerable interval from the time of drinking, as they alter the nature of the waters when mixed with them.

Alkaline
salts.

Vide Experiments on Bath Waters, p. 3.

These may be used if necessary, as they do not affect the qualities of the waters.

Acids.

NEUTRAL SALTS.

These may be used during the use of the waters, as they do not affect their qualities.

ABSORBENT EARTHS.

Earths of this kind, in their mild state, seem to produce little change on the qualities of the Bath Waters, on being mixed with them. They may, indeed, perhaps, detain the volatile vitriolic acid,

F f

and

PART IV. and hasten the precipitation of the ferrugineous particles, on which last account these substances must always be improper where any dependance is laid on that part of the impregnation. If any addition of that kind should, however, be thought necessary, I would advise the use of magnesia rather than any absorbents of the calcareous kind, on account of its laxative qualities; whereas the calcareous ones rather tend to promote a costive habit, which is already but too frequent an attendant on those who use the Bath Waters. It is possible that the opening effects of magnesia might be increased, on its being mixed with the Bath Water, as it might, in part, by its attraction of the volatile vitriolic acid contained in the water, be converted into a purgative earthy salt, though I can scarce think, that the quantity formed in this manner could produce any great effect. As magnesia, however, by itself, possesses, in many habits, the quality of keeping the body mildly open, an addition of this kind might be often of service, to be used with this intention, which it might, in many habits, answer as well, or better, than alkalines or
neutral

neutral salts, especially in those where acids abound in the first passages. It seems not improbable, that when we desire to increase the tendency of the waters to go off by the urinary secretions, that alkalines, or neutral salts, would be preferable to magnesia; but where keeping the body mildly open, and obviating acidities, were the points aimed at, magnesia might be more efficacious. PART IV.

Calcareous earths, in their caustic state, seem very improper additions, on many accounts, to the Bath Waters.

It appears by the Experiments, that a copious precipitation was generated in them, when fresh, on addition of lime water, which was, undoubtedly, caused by the lime in the lime water attracting the mephitic air from the Bath Water, and thus becoming mild, and of course precipitated. From this we may judge, that in all cases where the mephitic air may be of service, that lime water must be a very improper substance to be joined to it, as it absorbs it instantly, and unites with it very strongly. Lime water added to the Bath Water fresh, seems to impart no additional qualities to it, except a dis-

Lime water.

PART IV. greeable empyreumatic taste, the calcareous earth being separated in an insoluble form, and nothing remaining of it except the ungrateful flavour before mentioned. In all cases, therefore, where lime water may be prescribed to be taken with a course of the Bath Waters, I should recommend them to be taken with the greatest possible interval between each. As to the metallic preparations, viz. those of iron, antimony, and mercury, I have before spoken.

As the compound formed by admixture of milk with the Bath Waters is frequently prescribed to be taken in the way of medicine, it will not be entirely useless to consider here what may be the chemical effects of such a combination.

Milk.

The Bath Water, in the proportion of equal quantities, produces, with milk heated to the boiling point, a separation of its parts, the cheesy part dividing from the serous in form of a loosely cohering curd. In these proportions, however, the separation is by no means perfect, but when made with two parts of Bath Water to one of milk, the curd is then separated nearly
com-

completely; the whey thus made has little PART IV.
peculiarity of Taste, and, indeed, in most
of its qualities, by what I can find, differs
little from common whey made with an
acid substance, and diluted with water.
By the time and apparatus necessary for
making it, the aërial impregnation is en-
tirely dissipated, and it is not improbable
that the sulphureous one may be decomposed
by such addition, as the whey thus made
possesses very little, if any, of the peculiar
taste which the Bath Water acquires on
standing. On the whole, this compo-
sition, however specious, appears to be a
very incongruous one for the reasons above
mentioned; and the common pretence
alleged in the defence of it, that of
reconciling the stomachs and palates of
many to the Bath Water, who would not
else be able to bear it, seems by no means
sufficient to justify its use. Most of those
who come to Bath for stomach complaints,
receive the greatest benefit from that part
of the impregnation, which by this
means is entirely dissipated; not to mention
the bulk of the dose is thus increased one
third part, which is a matter of great
consequence in such cases. In these cir-
cumstances,

PART IV. circumstances, therefore, if the Bath Waters give disgust, or are with difficulty retained on the stomach, it would be more adviseable to reconcile their use by some grateful aromatic addition, and by lessening the doses of it, than by using it when its qualities are impaired, and its bulk considerably augmented. If whey, however, be deemed a necessary addition, I would advise a proportionable quantity of fresh whey, already made, to be added to the water, fresh drawn, and to be immediately drank, by which means the qualities of the waters will be little injured. I own that whey, drank at the same time with a course of the waters, especially in the spring season, might often, in many complaints, especially those usually called scorbutic, be a very proper prescript, as contributing to obviate the costive habit, and heating effects, which these waters so frequently occasion; but cannot see any necessity for mixing it with the waters, as its good effects would be equally powerful, if taken at some interval. On the whole, I am inclined to believe, that this remarkable effect of the water on milk, has contributed much to recommend the

the product of such a combination as a PART IV:
medicine, as imposing, by a kind of juggler's contrivance, on the understandings of many, and persuading them to believe, that so remarkable a production must have some very uncommon virtues. To sum up all, this preparation seems incongruous to the general intentions wherewith the Bath Water is prescribed, and not qualified to answer any purpose which might not as effectually be done by other means.

As to vegetable substances, I have before spoken concerning the impropriety of using those of the astringent kind with the Bath Waters. But this does not affect the Bitters, except combined with an astringent quality. Most of the woods, barks, fibrous roots, stalks, rinds of fruits, some leaves, and the cortical part of seeds, possess some degree of astringency; whilst, on the other hand, the pulps of ripe fruits, simple gums, essential and expressed oils, balsams, gum-resins, and bulbous roots, are nearly divested of it. It is probable, then, that all of the latter kind, if proper on other accounts, might be taken without any alteration of the qualities of the Bath Waters.

I have thus finished what I have to say on the subject of the internal use of the Bath Waters.

The present edition differs considerably from the foregoing, being much enlarged, and, I hope, somewhat improved. As to the circumstances in which it varies, I thought it better to make this general acknowledgment at the last, than perplex the reader with particular references in the course of the work. Where it varies, I think I have had sufficient reason for altering my opinion. I at first proposed to have included my sentiments on the external use of the waters in this Volume, but found the subject so copious, as to render an abridgement of it necessary to bring it within its present compass.

The second Volume, on the external Use of the Waters, will be published separately in a moderate time.

Whether I have succeeded in my attempt, the world will judge. I confess that the present work is defective in several respects, but I flatter myself, nevertheless, that as the general plan is, I
believe,

believe, tolerable, and the facts not (intentionally at least) misrepresented, that it may not be entirely useless to the world if it furnishes any materials or hints upon which some more able Writer may enlarge.

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E R R A T A.

THE Author being at a distance from the Press, the following Errata have happened, which the Reader is desired to correct. Perhaps more may have passed unnoticed, but it is hoped they are principally in the punctuation only, and such as may be corrected by observing the general sense of the Work.

Page 42, line 1, place *ACIDS* a general title.

P. 42, l. 3, place *VITRIOLIC ACIDS* as a title to the paragraph.

P. 49, part of line 9, and lines 10, 11, inserted by mistake.

P. 94, insert as a note to the title *Regenerated Tartar*.—Regenerated Tartar, formed by the acid of Tartar, and the vegetable, alkali is of a leafy foliated texture, remarkably deliquescent, though probably this quality is owing to too quick an evaporation of the water, in order to its crystallization. It dissolves easily, and in a small proportion of water, and generates heat with it. It is of easy fusion on the fire. It also dissolves in spirit of wine, and is said to promote the action of that fluid on gummy and resinous bodies, and even renders oils miscible with it, if not soluble in it. It promotes the action of alcohol on the calces of metals. It is generally thought that the different kinds of vegetable acids form salts of different qualities, but their distinguishing properties are not yet ascertained clearly.

P. *ibid.* Insert as a note to the title *Salt of Rochelle*.—Sal Polychrestum Rupellense is formed of the acid of Tartar and the fossil alkali. It crystallizes easily, and keeps dry and even calcines in the air. It is not of such easy fusion in the fire, nor so soluble in water, as regenerated Tartar. It is not soluble in spirit of wine. It is decomposed in the same manner as regenerated Tartar.

P. 95, insert as a note to the title *Vegetable Ammoniac*.—This is, probably, of as great variety as the vegetable acid, but as we see it, it is formed from vinegar and the volatile alkali. It is as we see it in a fluid form, though it may be got solid, though with difficulty. It renders oils soluble in ardent spirits, and promotes their action on gums, resins, and metallic precipitates, like regenerated Tartar.

For the means by which this, and the two foregoing salts may be decomposed, vide table of *Elective Attractions*, end of Part I.

P. 105,

ERRATA.

- P. 105, l. 7, ab imo for *its* read *their*.
 P. 110, l. 13, ab imo for *But* read *And*.
 P. 120, at Ardent Spirit, line 3, ab imo, insert SECT. III.
 P. 161, l. 12, ab imo, read, *left* the fluid above clear.
 P. 171, l. 1, a summo, insert as a title to the paragraph,
 MAGNESIA.
 P. *ibid.* l. 11, insert as a title to the paragraph, CRYSTAL-
 LINE EARTHS.
 P. 172, l. 4, for *Magraaf* read *Margraaf*.
 P. *ibid.* l. 10, as a title, read ARGILLACEOUS EARTHS.
 P. 173, l. 6, omit *in three ounces*.
 P. *ibid.* l. 10, insert as a title TALKY EARTHS.
 P. 185, lines 7, 8, and part of 9, inserted by mistake.
 P. 225, l. 5, ab imo, the ; should be placed after the word
 Selenites line 4.
 P. 258, l. 1, for *contained* read *imparted*.
 P. 322, CHAP. IV. read CHAP. I.
 P. 364, l. 12, for *Antiscorbutic* read *Antispasmodic*.

